23 JUL 1954

1953 Report

Experiment Station Committee

Hawaiian Sugar Planters' Association

THE COMMITTEE IN CHARGE

THE EXPERIMENT STATION
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

REPORT

October 1, 1952 to September 30, 1953

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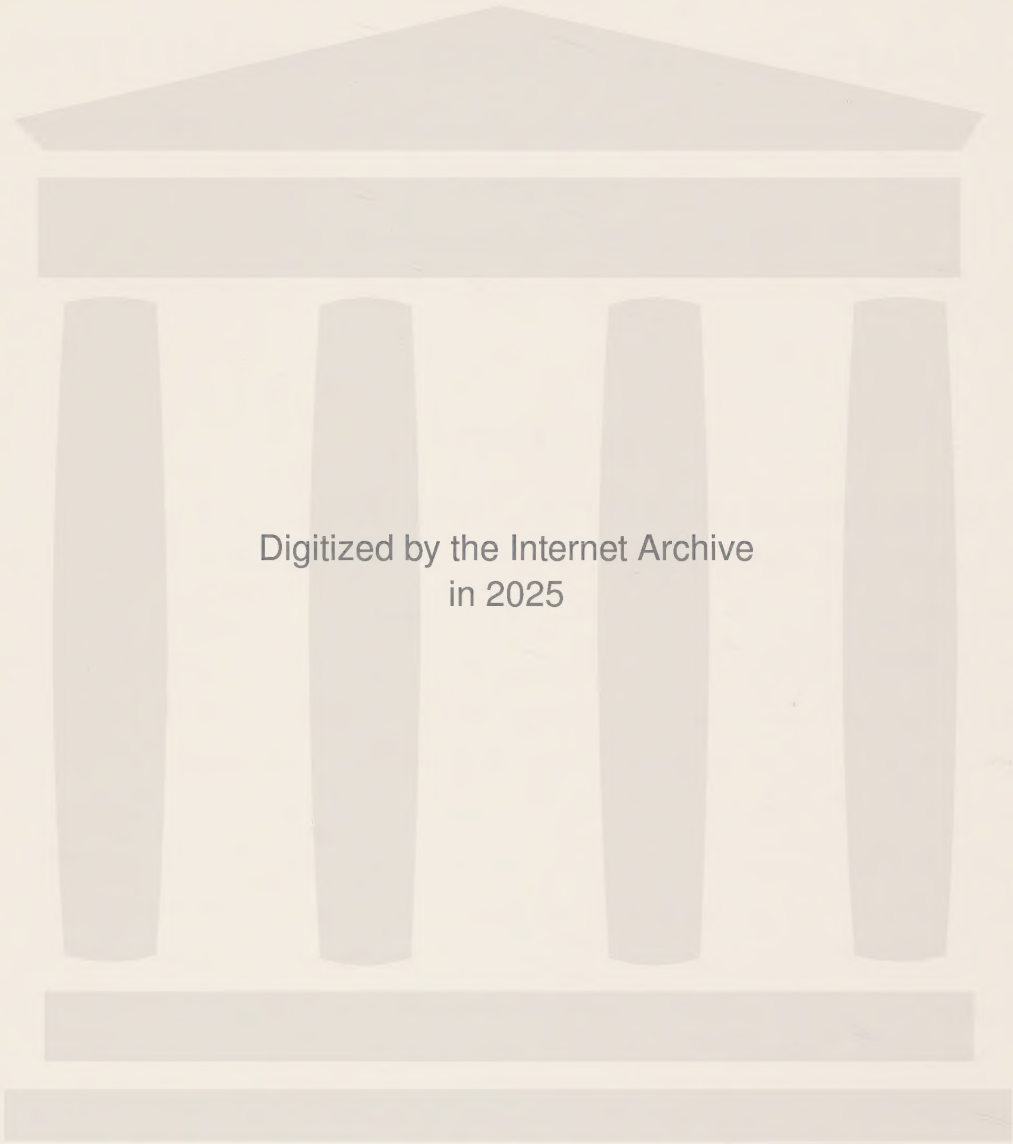
On the cover: Bagasse Fiber.
Courtesy, Crown Zellerbach Corporation.



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To the President and Members

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

Gentlemen:

The Experiment Station Committee is pleased to submit a report from the Director recording another year of substantial accomplishment.

To assure that the work of the Station is patterned to the needs of the plantations, the Committee once a year holds a meeting on each Island. In addition, a review of all projects by plantation managers is sought and their thoughts are brought to the Committee's annual review session by Island Associate Members.

In the field of agronomy, the Monthly Progress Reports have listed promising results on many plantations through the use of balanced fertilization.

Australian scientists have shown us how to recognize an apparently new cane disease—ratoon stunting. Fortunately, they have also given us a satisfactory means of controlling the disease. A Territory-wide survey by the Pathology Department has shown some evidence of symptoms but no stunting effects comparable to those on Australia's susceptible variety Q 28.

Screening of new herbicides continues to occupy most of the time of the Chemistry Department and during the year several promising formulations have been reported to the plantations through the Station's Special Releases.

Work done in by-products during the year has defined the extent of our interest in certain areas and opened up new leads in others. Our cooperative experiments with paper and fiberboard companies have demonstrated the superiority of bagasse over other fibers for certain products. Studies on the economics of the manufacturing of some of these products are under way.

The HSPA presented the Manoa Arboretum as a gift to the University of Hawaii. Through the beneficent interest of Dr. Harold L. Lyon, it will be maintained as an arboretum by the University, thus assuring the preservation of the many species of trees and other tropical vegetation brought into the Territory by the HSPA.

It is with regret we record the death of J. Douglass Bond, Coordinator of Training at the Experiment Station for nearly eight years.

Respectfully submitted,

THE EXPERIMENT STATION COMMITTEE, HSPA

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To

The Experiment Station Committee

Gentlemen:

I am happy to submit the Annual Report for the year ending September 30, 1953, which pinpoints the major accomplishments of the industry's Experiment Station.

The Director and the Staff of the Station want to emphasize that the results of research published herein could not have been achieved without the wholehearted cooperation of the various plantations. We express our sincere appreciation for the fine spirit of teamwork that has made these researches actually a Station-Plantation contribution, even though this is considered the Station's Annual Report.

Research in Agricultural Engineering was highlighted by redesigns of the "cutter only" for irrigated cane and the portable cane dry cleaner. The pegtooth drum principle of removing trash has been included in the wet cleaning plant at Olaa Sugar Company, Ltd. The cleaner itself is showing up well in field trials. The performance of the side-mounted cutter-windrower at Lihue, Hamakua Mill and Kaiwiki has been outstanding under the machine management program of these plantations.

Agronomic research has emphasized balanced nutrition, coordinated field experiments between plantations, better soil tilth and sounder irrigation practices. Second-season application of nitrogen by air has resulted from cooperative planning with agriculturists on several of the unirrigated plantations. The requests by plantations for studies of soil compaction have exceeded the ability of the Agronomy staff to handle all such inquiries.

Maleic hydrazide experiments at several plantations have indicated that the Department of Physiology and Biochemistry is finding the answer to practical tassel control. Many basic contributions have been made that will help answer a large number of the controversial points in sugar cane nutrition.

Two rather significant developments took place in sugar cane genetics. Cooperative agreements have been culminated between the HSPA and the Division of Sugar Investigations of the United States Department of Agriculture. One will concentrate on a study of the basic principles of flowering; the other on sugar cane cytogenetics. In addition, Dr. John N. Warner of the Department of Genetics has been made Chairman of a committee to arrange for establishing a world sugar cane breeding stock collection under the auspices of the International Society of Sugar Cane Technologists.

The Department of Entomology has been concerned over the threat of new leafhoppers entering the Territory through increased air travel.

Symptoms of a new disease apparently have shown up in Hawaii. Ratoon stunting, which has been found to cause considerable losses in Australia, has been diagnosed by visiting Australian pathologists as being present in some Hawaiian canes. The Department of Pathology already has a comprehensive field testing program to study the symptoms more thoroughly as well as how the disease, if present, can be eliminated. The cooperative project with the Colonial Sugar Refining Company to study Fiji and downy mildew diseases in Fiji is functioning in an excellent manner.

The worst drought in years visited the Territory in 1953. The Department of Geology has observed that low ground-water levels have resulted from long-time deficiencies in additions to the ground-water supply. The Department of Meteorology has given concentrated attention to the possibilities of artificial rainfall inducement.

New techniques developed by the Departments of Sugar Technology and Experimental Statistics are helping plantations evaluate sugar losses from field through the cleaning plant. These techniques offer promising possibilities for harvesting experimental plots and for sampling fields of cane.

By-products research showed that final molasses can be used in the poultry ration to produce eggs more cheaply than with mainland-type rations. Containers in which the corrugating medium was 100 per cent Hawaiian bagasse were found to be superior to all wood pulp paper boxes. Exceptionally fine results are coming from our cooperative research project with the Crown Zellerbach Paper Company.

Four Station scientists, Dr. G. O. Burr, Dr. R. P. Humbert, Dr. J. H. Payne and Dr. J. N. Warner attended the meetings of the International Society of Sugar Cane Technologists in the British West Indies, where their scientific contributions received warm praise from other delegates.

The Maui Variety Station was discontinued at the request of the Maui Planters' Association.

The Experiment Station and the Industry suffered a great loss in the death of J. Douglass Bond, Coordinator of Training Personnel. He will be missed greatly in the community, and especially at the Station.

A total of 818 volumes was added to the Library during the year. There were 1543 books loaned from the Library, of which 354 were borrowed by others than staff members.

Staff changes taking place during the year are listed on page 76.

Respectfully submitted,

EXPERIMENT STATION, HSPA

By L D Baver

Director

BY-PRODUCTS

CHEAPER EGGS WITH FINAL MOLASSES IN THE RATION

Cooperative experiments with the Department of Poultry, University of Hawaii, have shown that the chicken has an unexpected ability to utilize high concentrations of final molasses. It was found that eggs could be produced almost 24 per cent cheaper by feeding a ration containing as high as 28.4 per cent final molasses than by feeding the control ration which was made up entirely of mainland ingredients. The molasses was mixed with a small amount of bagasse pith, which served as a carrier.

These data point out the great economic importance of using final molasses in poultry rations not only to ensure a stable feed supply, but also to cut down the cost of production.

"B" MOLASSES-PITH MIXTURE PRODUCES CHOICE BEEF

Experimental trials with the Department of Animal Husbandry of the University of Hawaii have shown that "B" molasses-pith mixtures will produce good gains and high quality beef when fed to steers in the fattening lot (Figure 1). During the final 70 days' fattening period with 23 experimental steers, the average daily gain was 3.02 pounds. The minimum gain was 2.4 pounds, and the maximum was 3.94 pounds. There were 2.75 pounds of roughage and 8.98 pounds of experimental ration consumed per pound of gain. Further tests are being conducted to ascertain if the costs of the ration can be decreased so as to provide a feasible margin of profit in a pen-fattening operation.

Figure 1. Young steers in the feeding program, being fattened on "B" molasses and pith mixture.

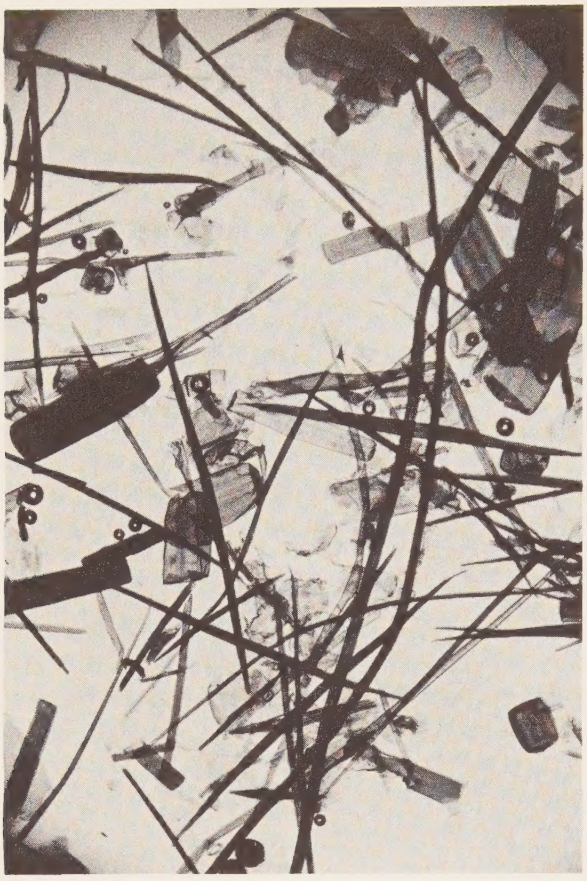


Figure 2. Bagasse fibers of the variety 37-1933.

CONTAINER BOARD FROM HAWAIIAN BAGASSE EXCELLENT IN QUALITY

Cooperative experiments involving the Northern Regional Research Laboratory at Peoria, Illinois, the New York State College of Forestry at Syracuse, New York, and the Container Laboratories in California, have shown that container board, in which the 9-point corrugating medium was made from 100 per cent Hawaiian bagasse, gave higher compression, flat crush and puncture strength than similar containers made from wood pulp. When made-up containers were tumbled in the regular drum tests, it was found that those made from Hawaiian bagasse had a longer life than those made from wood.

These promising data are being followed up with other tests and with an economic analysis of the possibilities of making container board in the Hawaiian Islands.

LEADING CANE VARIETIES HAVE GOOD FIBER CHARACTERISTICS

Fiber analyses from four leading cane varieties in Hawaii have been made by the Institute of Paper Chemistry through the cooperative project with the Crown Zellerbach Development Laboratory at Camas, Washington.

These data show that the length of fiber, as well as the length-to-width ratio of the fiber with the four varieties tested, range in the order of 37-1933>44-3098>32-8560>38-2915. Inasmuch as 37-1933 and 44-3098 have the longest fibers, these varieties should also be expected to produce the highest strength pulps (Figure 2).

STUDIES REVEAL CHEMICAL COMPOSITION OF BAGASSE

Cooperative studies with the Crown Zellerbach Development Laboratory at Camas, Washington, reveal that there is little variation in chemical composition of bagasse from different varieties. Hawaiian canes were observed to have a high pentosan and holocellulose content and low lignin. These characteristics are favorable from a standpoint of production of pulp for various types of papers. On the negative side, it was found that the alpha cellulose content was low and the ash content high.

These chemical data are being analyzed with respect to the by-products possibilities of bagasse.

STANDARD PULPING PROCESSES ADEQUATE FOR BAGASSE

Cooperative studies with the Crown Zellerbach Development Laboratory have also indicated that Hawaiian bagasse can be pulped by standard methods of wood pulping if such factors as time and chemical concentration are adapted to the properties of the bagasse.

Bagasse requires less chemical and shorter cooking. It has been observed that the partial removal of pith is essential to decrease the amount of chemical used and to increase the freeness, strength, and cleanliness of the pulp obtained.

Further studies contemplate a comparison of the effects of different methods of cooking on the strength of the pulp and the economy of the operation.

REPORT TO SUGGEST POSSIBILITIES OF AMMONIA PRODUCTION IN THE ISLANDS

Although an analysis of the possibility of making ammonia from bagasse has shown that such an operation would not be economically desirable, a report on the possibilities of producing ammonia from fuel oil is being prepared. The economic and strategic desirability of producing ammonia in Hawaii justifies the industry, in turn, in making an early examination of the means for initiating such an enterprise.

CULTURAL PRACTICES

BALANCED NUTRITION—A GOAL FOR THE FUTURE

The Department of Agronomy's objectives in research center on the production of ever-increasing yields of cane and sugar through balanced nutrition and cultural practices that eliminate the "bottlenecks of production." Replicated field experiments installed in 1951 and harvested this year emphasize the importance of checking the plant food reserves in the soil, determining the requirements for optimum yields of cane, and meeting the deficits in a fertilization program designed to feed both the primaries and secondaries and to insure their maturity at harvest.

The yield data of Olaa Sugar Company's Experiment 101 AP Ca x ANK are an example of the type of information being secured which guides profitable fertilization. The results are as follows:

Treatment	TCA	Q.R.	Y%C	TSA
0# P_2O_5	59.9	7.4	13.6	8.2
200# "	75.4	7.6	13.2	9.9
LSD	10.5	....	ns	1.3
0# CaO	70.7	7.6	13.1	9.2
290# "	75.6	7.5	13.4	10.1
580# "	79.9	7.6	13.2	10.6
LSD	ns		ns	ns
175# N + 350# K_2O	66.4	7.5	13.4	8.9
225# N + 450# K_2O	76.6	7.5	13.3	10.1
LSD	9.1	....	ns	1.1

Highly significant increases in yields of cane and sugar were obtained for phosphate fertilization. In addition to response from phosphorus, significant gains resulted from 225 pounds nitrogen and 450 pounds N and 350 pounds K_2O.

The higher yields require balanced feeding and the elimination of the various limiting factors of growth as they appear.

The spectrograph, after two years of intensive calibration, is now a valuable tool in the nutrition research. Quantitative spectrochemical analyses of over 150 cane samples have been completed. Effort is being directed toward the establishment of critical levels of the minor elements in sugar cane. The influence of the concentration in the plant of one element upon another is also being studied.

Potassium Survey Completed for All Plantations

Because increased potash fertilization requirements as defined by replicated field experiments and crop logging techniques were being challenged, a survey was conducted of all plantations from 1926 to and including 1952, covering the tons of K_2O sold in molasses, the K_2O purchased in fertilizer and the net deficit drawn from the soil reserves. In most unirrigated plantations, the reduction in the soil potash reserves, particularly during the 1940's, was staggering. The data show why increasing rates of potash fertilization are needed to supply the requirements of record-producing crops.

Research on the fixation of potassium by Hawaiian soils was completed. The highest fixation in laboratory tests was obtained with the dark magnesium clays which fixed 15 to 20 per cent of the added potassium, and with the gray hydromorphic soils which fixed somewhat less. These studies explain why large applications of potash fertilizers are required in these soils to maintain adequate levels of potassium in the cane plant.

On the irrigated plantations, a study of the composition of well waters is continuing. These data are necessary to complete the balance sheet for potassium. Periodic analyses of Maui well waters over a period of one and one-half years showed a remarkable constancy in content of potassium. Average K values for 16 wells at four successive periods were 14, 15, 15 and 14 ppm.

The study of differential losses of potassium by leaching from various salts of the element was extended to the soil, a low humic latosol, of an irrigated Oahu plantation. Unlike the humid region soils previously reported upon, this soil sustained negligible losses of potassium, regardless of the salt employed.

Critical Levels of Soil Potassium Established

Three years of research correlating soil analyses from replicated amounts of potash experiments show that there is little chance of response to additions of potash where the level of exchangeable potassium at the start of the crop exceeds 110 ppm. Below 75 ppm, response to potash is the rule. There have been no exceptions on soils containing less than 60 ppm.

The soil analysis procedure for potassium has been developed to measure the potash reserves in the soil and to supplement foliar analyses.

In cooperation with the Department of Physiology and Biochemistry, rubidium, as a tracer for potassium in the plant, was fed in culture solution to a normal plant of 37-1933 at 4½ months of age. Two months later, the plant was harvested and potassium was determined by the Chemistry Department with the flame photometer, while the rubidium was determined by Geiger counting. Figure 3 shows that rubidium follows potassium quantitatively in the different tissues and may serve as a potassium indicator. This will be very helpful since there is no radioactive potassium with a convenient half-life.

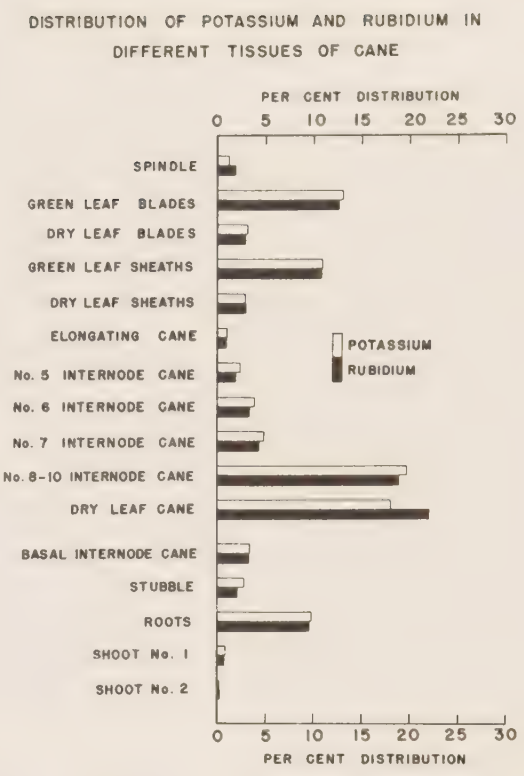


Figure 3. Distribution of potassium and rubidium in different tissues of the cane plant, shown graphically.

Soil Phosphorus Analyses Accurately Defining the Need for Phosphate Fertilization

General and frequently substantial increases in sugar yields continue to result from the application of phosphate to soils that the HSPA modified Truog procedure has shown to be deficient in phosphorus.

The critical level of 20 ppm continues to hold for the low volume weight soils for which it was originally established.

Previous studies with radioactive phosphorus determined that the most effective position of the fertilizer was with the seed at planting. Field experiments harvested over a four-year period show that heavy applications with the seed are as effective as smaller amounts at the start of each crop.

Savings in phosphate fertilizer have been realized wherever it has been shown that soils already contained adequate supplies of available phosphorus.

As a part of the general program of nutrition studies made by the Department of Physiology and Biochemistry, the phosphorus has been subdivided into numerous chemical fractions. It has been found that age and location within the plant greatly affects the nature of the phosphorus compounds present. There is some indication that clear-cut evidence of phosphorus deficiency may result from this study.

By paper chromatography, the phosphorus in sugar cane leaves has been subdivided into the following percentages: Inorganic phosphate, 51; 3-phosphoglyceric acid, 22; Phospholipids, 15; Adenine triphosphate + Adenine diphosphate, 1.4; Glucose-1-P, 2.5; Fructose-6-P, 0.05; unknown diphosphate, 0.7; and unaccounted for, 7.35.

Studies Precede Field Scale Use of Aqua Ammonia

Starting next January, the price advantage which aqua ammonia will have over the other nitrogen fertilizers forces the first major change in N fertilization in the last 20 years. Tests have shown that cane shows no preference for any one of the various forms of nitrogen; so cost per unit of nitrogen applied will continue to determine which nitrogen fertilizers are to be used on the sugar plantations of Hawaii.

The applications of liquid fertilizers necessitate

consideration of many factors. The use of liquid fertilizers in planting machines or at planting time is being considered by a number of plantations. Certainly the greatest advantage will be realized by the irrigated plantations where subsequent applications of nitrogen can be made in irrigation water.

Fertilization in irrigation water has never been wholeheartedly accepted. The industry has realized for a long time that distribution of water has been far from satisfactory. Higher and higher acre-inch applications have been necessary to hide the weaknesses in our systems of irrigation.

A survey is being completed on the distribution of irrigation water on the principal types of soil and under the various systems of irrigation. Radioactive materials and tracer techniques are being used to evaluate irrigation performance. Where reasonably good distribution of water is found, satisfactory applications of nitrogen as aqua ammonia can be made. Where poor distribution is recorded, changes in field design—irrigation system, length and slope of lines—will need to be made to permit fertilizer applications in water. On the basis of these studies, it has been recommended that no applications of fertilizer be made in irrigation water in the porous volcanic soils where an even distribution of water is not possible under furrow irrigation.

Studies to date have shown reasonably satisfactory applications of aqua ammonia from soil injections. The losses have been checked under a wide variety of conditions and found to be very low—low enough to maintain the advantage of the cheaper source of nitrogen.

Due to appreciable losses, surface applications were shown to be impractical. Controlled studies in the laboratory simulating field conditions show that the losses from surface applications to dry soils range from 10 to 13 per cent. When the soils are wet, the initial losses are smaller, but still appreciable. Surface applications to soils covered by a blanket of cane trash result in losses up to 20 per cent. Numerous field experiments have been installed to check for optimum depth and position of aqua ammonia placement.

Ammonium sulfate, tagged with heavy nitrogen (N_{15}), was fed to stools in the field at the same level but in the following ways: all at ratooning; half at ratooning and half after three months; one-third at ratooning, one-third after three months, and one-third after six months. These plots were harvested at 18 months of age, and the distribution of N_{15} is being determined. These basic data should provide a better understanding of nitrogen utilization by a growing crop.

Air Fertilization Program Expanding

Harvesting results of a number of cooperative experiments have shown increased yields of cane and sugar where fertilizer was applied to the foliage as a spray and where deficiencies of N or K or both existed. Emphasis has shifted from foliar sprays to applications of dry fertilizer by duster equipment because of the cheaper application rates (Figure 4). Observations to date show that the cane, particularly the secondaries, has responded to the late first season or early second season fertilization. This practice is becoming increasingly popular with the unirrigated plantations and is being considered by several irrigated plantations whose distribution of irrigation water is poor.

EFFECTS OF CLIMATE ON SUGAR CANE GROWTH AND COMPOSITION

Although data from the most recent harvest in the controlled climate houses are only partially tabulated, a few striking results can be pointed out at this time.

A. Nitrogen uptake and distribution. The rate of nitrogen absorption is independent of air temperature but strongly dependent upon root temperature below 80°. Since the temperature coefficients for growth and nitrogen absorption are not the same, the resultant nitrogen concentration after a period of growth will be very different. Figure 5 shows the over-all average trend for two varieties, 37-1933 and 44-3098, at two nitrogen levels.

The following general conclusions can be drawn from the data thus far analyzed.

1. The relative rates of nitrogen absorption from the same culture solution at different root temperatures are:

$$\frac{90°}{80°} = 1;\ \frac{80°}{70°} = 1.42;\ \frac{80°}{60°} = 2.72 \text{ and } \frac{70°}{60°} = 1.92$$

Figure 4. At the top, N-K fertilizer is mechanically loaded into a plane for second-season fertilization. The hoppers hold from 1200 to 1500 pounds of fertilizer and large acreages can be dusted in a relatively short period of time. Below, a field which has been fertilized by air shows good distribution and effective utilization by the evenness of color in the treated strips.

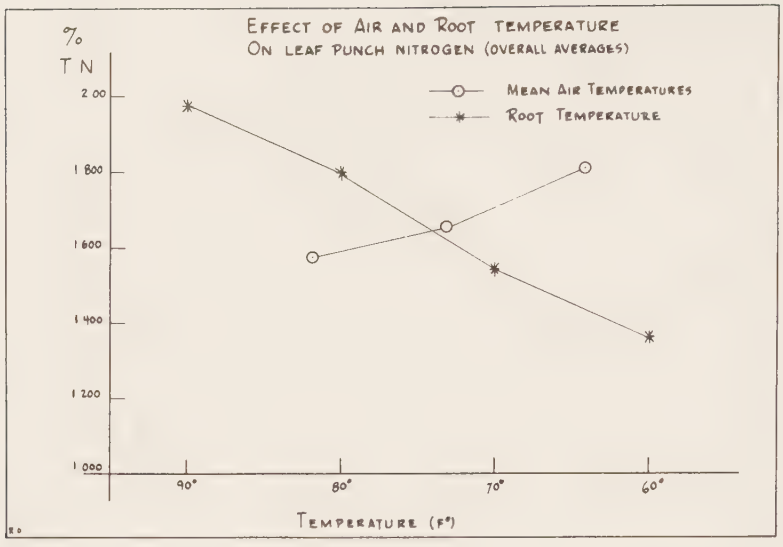


Figure 5. The opposing trends of leaf N due to air and root temperatures are here shown. Very different nitrogen values result from the various combinations of root and air temperatures.

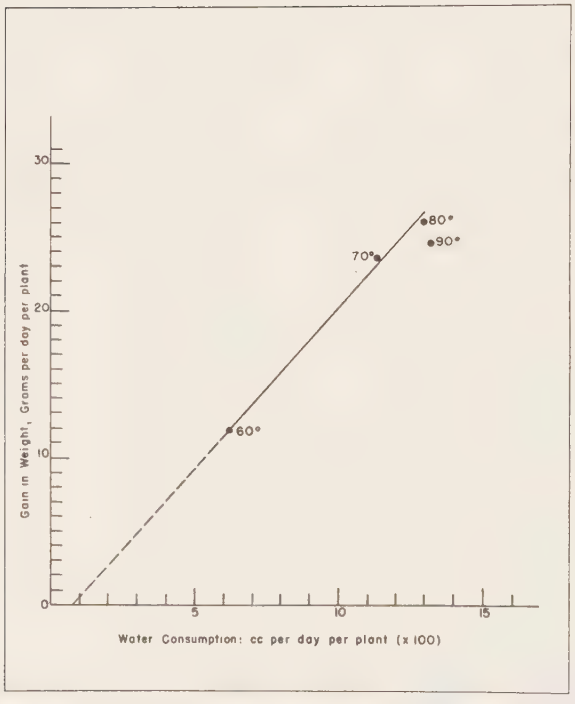


Figure 6. Relation between water consumption and gain in weight as affected by root temperature.

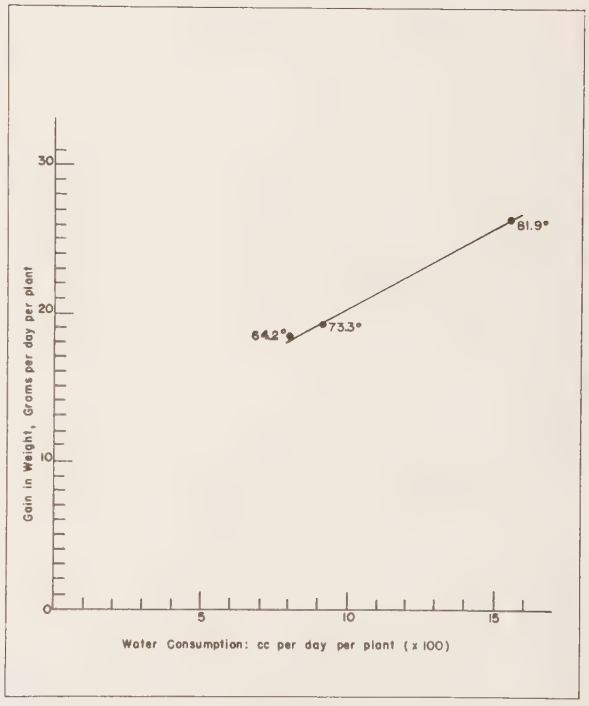


Figure 7. Relation between water consumption and gain in weight as affected by air temperature.

A change of 18°F in mean air temperature does not affect nitrogen absorption.

2. The leaf punch nitrogen in variety 37-1933 is 43 per cent higher than in 44-3098 under comparable conditions.

3. Under the good growing conditions of high air temperature, the leaf punch N shows a regular small response to extra nitrogen; but in cool weather the leaf N data fluctuate, and plants fed more nitrogen may have the lower leaf N content.

4. In no case does the basal soluble nitrogen show such reversals, and in general its response to nitrogen feeding is greater than in leaf N.

5. In high air temperatures (81.9°F mean) the optimum root temperature for growth is 80°F. However, in cool air (64.2°F mean) the optimum root temperature is 70°F.

B. Climate and Water Consumption. There is a close relationship between water consumption and growth. Figures 6 and 7 illustrate some striking correlations. Figure 6 shows that plants growing in the same conditions of air temperature and radiation use exactly the same amount of water per gram of growth. When root temperature becomes excessive, i.e. no increase in growth with increased temperature, there may be loss in efficiency. The grams of water per gram of plant at root temperatures of 90°, 80°, 70° and 60° are 53.6 cc., 49.8 cc., 48.3 cc. and 51.8 cc. However, plants growing in different air temperatures show a decreasing efficiency with increasing temperatures (Figure 7). At air temperatures of 64.2°, 75.3° and 81.9°, the grams of water used per gram of plant growth are 43.5 cc., 47.1 cc. and 58.7 cc., respectively. This loss in efficiency may be due almost entirely to the fact that the increase of growth with temperature is less than the increase of vapor pressure of water at that same temperature.

C. Day-degrees and Growth. The hot house, which is 18°F warmer than the cold house, produced 50 per cent more cane. This figure of 3 per cent per degree is exactly the same as the one found for earlier crops.

The average daily maxima for the two houses were 73.90°F and 92.33°F, respectively. The accumulated day-degrees in the hot house were 5.72 times those in the cold house. With a growth ratio of only 1.5, the lack of proportionality of growth to day-degrees is evident. A base much lower than 70° or even 68° must be chosen for this calculation. By extrapolation, the temperature of zero growth would be 37°F. This is probably far too low and it is to be expected that a sharp break in the increase of growth with temperature will be found in the low sixties or fifties.

D. Growth of Cane in Field Plots Measured with Cobalt 60. Figure 8 shows the tonnages of cane in fall and spring plantings of varieties 37-1933 and 44-3098. Each was measured at six months of age without cutting and left to grow for future measurements. It seems that growth of 37-1933 is reduced more by winter cold than that of 44-3098.

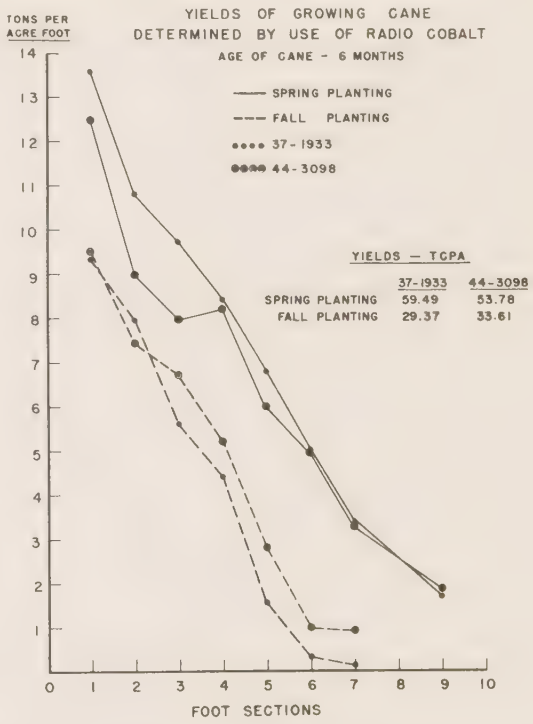


Figure 8. Radio cobalt is used to determine yields of growing cane.

Figure 9. The performance of subsoiling operations is ineffective in wet soils.

TILLAGE INVESTIGATIONS REVEAL WEAKNESSES IN EQUIPMENT PERFORMANCE

Cane germination and early development was observed to suffer from damaging compaction on seven unirrigated plantations using varied furrow-making devices and with planting machines operating under moist soil conditions at two irrigated plantations. The damage was traced to compaction of the recently tilled soil beneath the tractor track and the cutting of a trough by the furrowing device so that the seed cane was surrounded by compacted soil on three sides when planted. The effect of restricted early growth is observed to persist for several weeks.

Disc harrowing was found to be an undesirable operation on 10 plantations when practiced under moist soil conditions. Its use caused a compacted horizon throughout the plow depth except for the surface two to four inches.

Cultivation of Questionable Benefit to Wet Unirrigated Plantations

Cultivation practices have been critically studied at five unirrigated plantations. The practice as handed down through the years is a relic of the times when cultivation was necessary for weed control. With effective chemical weed control, and a lack of serious surface crusting of soils, the need for cultivation is questioned. Field studies by the Department of Agronomy have shown more instances where detrimental effects have been observed than where improved tilth has resulted from cultivation operations (Figure 9). The percentage of time is relatively small when the moisture level in the soil favors tillage operations subsequent to the preparation of a satisfactory seed bed.

COMPACTION REDUCES EFFECTIVENESS OF CANE ROOTS

Soil compaction, which distorts normal root growths, has been under study for three years. Several of the principal types of soils were compacted to seven degrees, varying from 41 to 100 pounds per cubic foot. Radioactive rubidium was placed in the centers of the compacted cores which were then set in pots of the same soil type, and planted to cane (Figure 10). The effectiveness of cane root systems was measured in the soils of varying density by checking the rate at which the rubidium was removed. Critical levels of compaction were established in terms of soil density, a measurement which may be easily determined in the field. When operations of heavy equipment cause puddling and compaction beyond these critical levels, corrective measures are required to restore the soils to satisfactory tilth.

Studies on four plantations on the Hilo Coast showed that soil damage resulted from more than two passes of the infield transport units under normal soil conditions. The reduced rates of subsequent cane growth were due to compaction and not to physical damage to the cane stools.

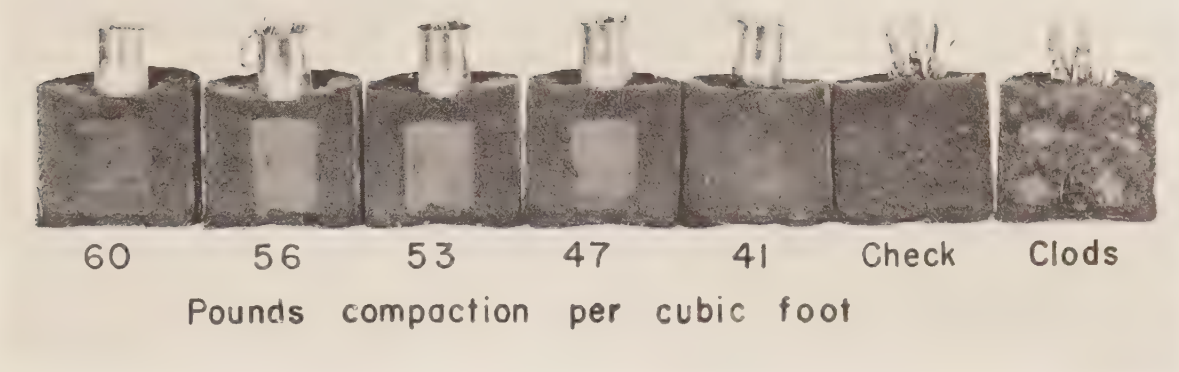


Figure 10. Root penetration studied in Pepeekeo soil compacted at 60, 56, 53, 47 and 41 pounds per cubic foot, as well as in a check and in clods. Note the inability of the root to penetrate soil compacted above 41 pounds per cubic foot.

Figure 11. Here are shown the compaction and puddling by loaded Tournahaulers with 10, 20 and 50 passes under wet soil conditions (4-inch irrigation) with 40 psi tire pressure on right.

Tournahauler Operations Under Critical Review

Compaction problems on infield Tournahauler roads are severe! Studies conducted during periods when the soils were wet showed pronounced compaction to a depth of 16 to 18 inches, reaching maximum soil density after 10 passes. Soil conditions did not prevent compaction, and a six-inch mat of bagasse merely reduced the depth of compaction by the thickness of the mat. Tests are being conducted under wet and dry soil conditions, with tires of various sizes and at varied internal pressures, and with loads of several weights (Figure 11).

Equipment Performance Checked for Efficiency in Seed Bed Preparation

A survey was initiated to check the effectiveness of different types of plows and other tillage implements in use on the plantations. The results of these studies have: (1) altered the timing of subsoiling operations, (2) changed the sequence of some operations, (3) called attention to limitations in performance of specific pieces of equipment, and (4) in general awakened an interest in the job being done by each piece of equipment used in the preparation of a seed bed.

CONTROL PROCEDURES ESTABLISHED FOR EARTH-FILLED DAMS AND RESERVOIRS

Earth-filled dam investigations were conducted for a total of five reservoirs. Standard compaction curves were obtained for all possible fill materials at each reservoir site. Confined swell, unloaded and with a surcharge, along with permeabilities, were determined at maximum compaction and optimum moisture. The data were used to select the best material for the fill, and control procedures were prescribed to ensure compaction at optimum moisture levels for maximum density and stability.

IRRIGATION EXPERIMENTS SHOW POSSIBILITIES IN WATER ECONOMY

Five replicated field experiments harvested during 1953 show that no losses in cane or sugar yields result from irrigation intervals controlled at a point where two-thirds to three-fourths of the available water has been removed from the zone of maximum concentration of roots. Data from Ewa Plantation Company's Experiment 1017I (Figure 12) clearly show the variations in moisture stress at different depths in this gray hydromorphic soil. These data emphasize the importance of placing the control instruments near the bottom of the zone of maximum root concentration. Note, for example, that in March, when the resistance at the 18-inch depth was about 1600 ohms, the resistances at the 12 and 6-inch depths were about 2200 and 5500 ohms, respectively.

Marked reductions in the number of rounds of irrigation were realized in the treatments controlled by the blocks at approximately 4 atmospheric tension when compared to plantation practice and particularly to tensiometer control. The following data summarize the results of three experiments harvested at Kekaha Sugar Company, Ltd., The Lihue Plantation Company, Ltd., and Oahu Sugar Company, Ltd:

Treatment (22 replicates)	TCA	Q.R.	Y%C	TSA
T = Tensiometer (.25 atm.)	112.0	7.3	13.7	15.3
B = Bouyoucos (5000 ohms)	109.2	7.1	14.1	15.4
X = Plantation practice	110.0	7.0	14.2	15.6
LSD	ns	....	0.4	ns

Treatment	Irrigation Rounds Kekaha	Lihue	Oahu
T = Tensiometer (.25 atm.)	40	53	39
B = Bouyoucos (5000 ohms)	19	24	21
X = Plantation practice	22	31	23

Moisture Tension Characteristics Determined for Principal Sugar Cane Soils

Approximately 100 moisture tension curves were established for the principal soil types on the irrigated plantations. These data are being supplemented by additional curves from Hawaiian Commercial and Sugar Company, Ltd. and Kekaha where equipment for these determinations has been installed. These characteristic curves will serve as the basis for scientific irrigation control in future years.

Bouyoucos Block Irrigation Control Expanding

Over 5500 Bouyoucos blocks were manufactured by the Department of Agronomy for use in irrigation experiments and in other experimental programs where the irrigation intervals were controlled by blocks. Thirteen of the 17 irrigated plantations have some acreage under block control. During periods of drought and of extended water shortage, the blocks are proving particularly useful to specify which fields are in greatest stress.

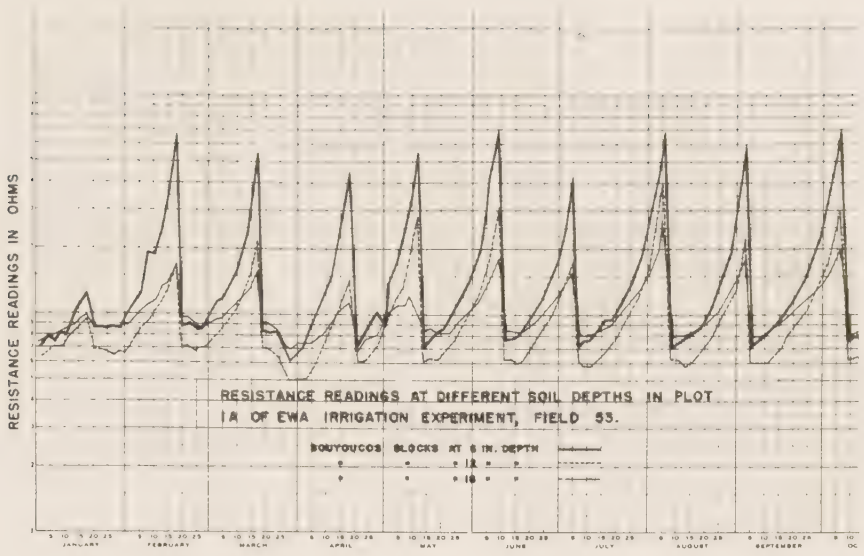


Figure 12. Variations in moisture stress at different depths in Ewa's gray hydromorphic soil.

Plastic molds were designed for mass production of plaster of Paris blocks for those plantations using the blocks for irrigation control on thousands of acres. Over 220,000 feet of field lead wire were used in establishing field control stations in the industry this year.

SOIL IMPROVEMENT OPERATIONS EXPANDING

The experimental testing program in the incorporation of cane trash and excess bagasse into soils whose poor physical properties limit production has shown:

(1) That increased yields of 1 to 2.7 TSA can be expected for application of 15 to 20 tons per acre.

(2) That the improvements in soil tilth will last a minimum of 10 to 15 years.

(3) That the cane trash and bagasse, when stockpiled for a period of two years under hot dry leeward climates, or for six months under wet humid windward climates, can be easily incorporated with present tillage equipment.

(4) That the nitrogen requirements of the cane planted in soils improved with stockpiled organic materials is no larger than the normal requirements. Previous studies have shown that additional nitrogen, 6 pounds N/ton of fresh bagasse, is necessary to satisfy the requirements of the decomposing organisms and the sugar cane.

These studies have resulted in:

- Field scale soil improvement programs at Kekaha and Ewa, where the gray hydromorphic and dark magnesium clay soils are being treated with stockpiled trash and bagasse (Figure 13).

- Field scale applications of bagasse at Olokele Sugar Company, Ltd., to increase the water penetration and water-holding capacity of their impermeable red soils.

- Field scale applications to sandy spots and heavy clay areas at Kahuku, where the soil improvement program is designed to minimize the special treatments in irrigation, fertilization, etc., which are normally required for small areas within larger fields.

- Enlarged testing programs on a number of other plantations.

Figure 13. Soil improvement is shown in the gray hydromorphic soils at Kekaha. At the top left, composted trash is loaded for hauling to the field. Top right, the trash is dumped in the field prior to plowing. Center left, in seedbed preparation, the Storey plow is used following the operations of the Towner plow and the Howard rotary hoe. Center right, a close-up of the seedbed after trash has been incorporated. Below is shown the improvement in soil tilth two and one-half years after bagasse was incorporated at the rate of 15 tons per acre.

GROUP TESTS PROVE PROFITABLE AND POPULAR

Six new group tests were installed in 1953 between various plantations to take advantage of benefits derived from this experimental design planning of the Department of Experimental Statistics. Such tests spread the replications over more than one plantation, make possible a better statistical analysis of the results, give greater assurance of the statistical significance of the differences obtained, permit a wider interpretation of the data, and provide the means for cooperation between plantations toward a common objective.

The tests installed were as follows:

Group Test No.	Objectives	Participating Plantations
15	Variety x Amts. of N	Hakalau, Pepeekeo, Laupahoehoe
16	Variety x Amts. of N	Hakalau, Pepeekeo, Laupahoehoe, Onomea
17	Amt. & Time of N & K	Hakalau, Pepeekeo, Hilo Sugar
18	Amts. & Forms of K	Hakalau, Pepeekeo,
19	Evaluation of CMU	Olaa, Oahu, Lihue, Kekaha, Kahuku
20	Evaluation of Maleic Hydrazide	Kauai Plantations

DISEASES

COOPERATIVE DISEASE TRIALS IN FIJI SUCCESSFUL

Very satisfactory progress is being made in the six-year program, which was started in 1951, in cooperation with the Colonial Sugar Refining Co., Ltd., for the purpose of testing Hawaiian-grown cane varieties in Fiji against downy mildew and Fiji disease.

The first lot of 100 varieties was sent to Fiji in 1951, the second lot of 25 varieties in 1952, and the third lot is due to be sent in the fall of 1953. Since all canes undergo a year's quarantine before they are tested, C. A. Wismer went to Fiji in December, 1952, and assisted staff members of the C.S.R.Co. to install the disease trials of the first 100 varieties. All 100 varieties were included in the Fiji disease trials; 57 varieties in the downy mildew tests. The reaction of this first shipment of canes to the two diseases will not be determined until the end of this year, but preliminary results show that the varieties 32-8560, 37-1933 and 37-7202 are resistant to downy mildew and that 44-3098 is susceptible.

MOLOKAI QUARANTINE SCREENS NEW CANES

Periodic inspections of imported canes for new diseases under greenhouse and field quarantine at Mapulehu were made throughout the year in cooperation with members of the Quarantine Committee.

Cuttings of the 102 canes selected from fuzz imported from Australia in 1951, and of the 31 varieties imported from Washington, D. C., during that same year, were released from the quarantine field for planting on Oahu after they had been given the hot water treatment (HWT).

Cuttings of the 28 varieties imported from Washington in March, 1952, were released from the quarantine house, given the HWT, and planted in the quarantine field.

The orange-red vascular bundles at the cane nodes, which are the internal symptoms of ratoon stunting, were observed on several of the imported and standard varieties. Before the cuttings were released from quarantine field V-2, they received the HWT, 52°C for 90 minutes, which controls ratoon stunting. No other symptoms of the major diseases were found on the varieties.

THE LOCAL CANE DISEASE PICTURE

Surveys of all plantations made during the year revealed that chlorotic streak, leaf scald and pineapple disease are causing some losses in certain areas. Special Release 79, sent to each plantation, outlines recommendations for controlling these diseases. The study of all diseases which are presently causing losses continues to be directed toward developing more efficient methods of control.

Ratoon Stunting

While no cases of growth failure of unknown cause were observed or reported this past year, acute symptoms of growth failure, unlike any previously recognized in Hawaii, were observed on the varieties 47-4991 (Figure 14) and 47-112 during June, 1951. Microscopic examinations and isolation studies failed to reveal any organism associated with the diseased conditions. In general, the symptoms resembled those of ratoon stunting disease, and are now believed to be identical to them. Since then, the internal symptoms of ratoon stunting have been found on the commercial varieties and on a number of the newer canes in Hawaii.

Investigations of ratoon stunting are receiving particular attention. The disease is not of major economical importance at present, nor are its symptoms widespread. Nevertheless, its mere presence constitutes a threat which causes considerable concern.

Figure 14. The effect of ratoon stunting on the variety 47-4991 is shown. Note acute growth failure in contrast with normal growth made by surrounding varieties of the same age.

Ratoon stunting disease was first reported in Australia, later in India, Africa, Mexico, the British West Indies, Puerto Rico, Louisiana and Florida. It is recognized by depressed growth, small stalk diameter, and the presence of orange-red vascular bundles in the nodes (Figure 15). The discoloration of the vascular bundles is the chief symptom of the disease. Affected canes, apparently making a normal growth, may manifest this internal symptom only. The symptoms are most pronounced on canes which are making a poor growth because of insufficient soil moisture or low soil fertility. The disease becomes more severe in successive ratoon crops. It is infectious, and may be transmitted by cuttings, by contaminated knives, and by juice expressed from diseased plants and injected into healthy cuttings or plants. With certain varieties, losses may be as high as 20 per cent in the plant crop and 60 per cent in ratoon crops.

D. R. L. Steindl, Pathologist of the Bureau of Sugar Experiment Stations, Queensland, visited the Experiment Station in March, and again in August of this year. The symptoms described in the Station's Monthly Report for January, 1953, as similar to those of ratoon stunting were, in his opinion, identical to those in Australia.

Ratoon stunting in Australia is associated with yield decline of varieties. It is believed to be a disease of long standing which "remained unnoticed until the introduction of a particularly susceptible variety". The variety referred to is Q 28. The recognition of ratoon stunting was coincident with the spread of this variety which had risen rapidly as an outstanding commercial cane in the Mackay district and which, being highly susceptible, had contracted the disease from a tolerant variety. Some investigators are of the opinion that, through the control of the disease, the old varieties which have declined can be rejuvenated and the life of the present commercial varieties can be prolonged.

In Australia, ratoon stunting has been controlled by selecting healthy planting material and by subjecting diseased seed to the hot water treatment, HWT (52°C for 90 minutes, or 50°C for two hours), or to the hot air treatment, HAT (54°C for eight hours). The short HWT (52°C for 20 minutes) which has been used for many years in Hawaii, does not control ratoon stunting, although it does control chlorotic streak and gives a partial control of leaf scald and other diseases. It also stimulates germination of cane cuttings.

In order to answer basic questions on the transmission of ratoon stunting, the reactions of the leading varieties to the disease, and the losses caused by the disease, as well as the degree of control given by the long heat treatments, experiments have been designed

and installed at the Pathology Plot, at Makiki and at Waipio. The first tests having to do with the transmission of the disease by cane juice and with the control of the disease by the long heat treatment were installed at the Pathology Plot in January of this year.

For establishing disease-free areas as seed sources for commercial plantings and for spreading or testing new varieties, the long heat treatments are recommended. They are not recommended as a general practice for field planting because they greatly reduce the germination of some varieties. In developing disease-free areas, it is advisable to plant 20 to 30 per cent more seed than normal in order to insure a satisfactory stand. The use of sterilized knives for cutting seed in these areas is extremely important.

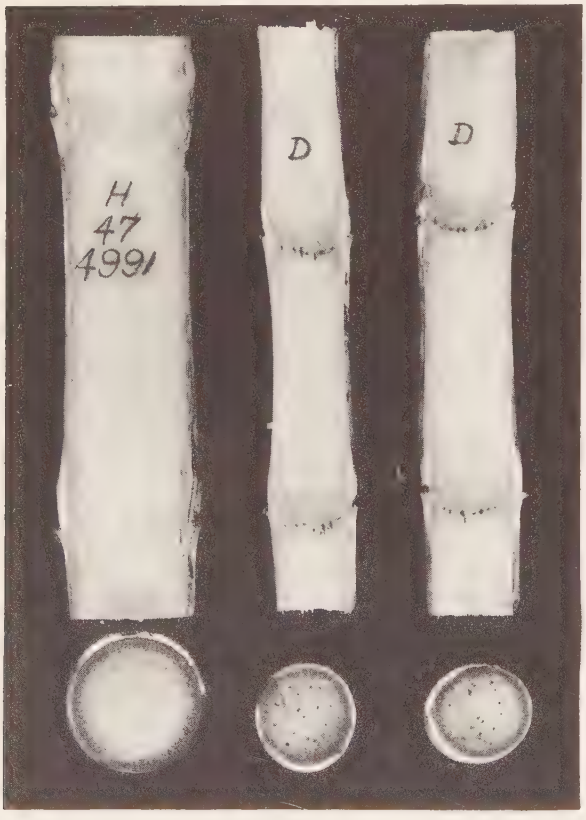


Figure 15. Internal symptoms of ratoon stunting on 47-4991 are shown in the two stalks at the right (D). Affected stalks, when split, exhibit reddish vascular bundles at the nodes. A portion of a healthy stalk of the same variety is shown at the left.

It is strongly recommended that prior to planting, all planting material from disease-free nurseries receive the HPMA (50°C for 20 minutes in a 1:1600 solution of PMA). If this is impossible, then all freshly cut ends should be dipped or sprayed with a PMA solution (1:400).

Chlorotic Streak

Chlorotic streak is confined chiefly to the heavy rainfall areas on Hawaii. Sugar losses from the disease on 44-3098 as measured in the Grade A test harvested in June, 1953, at Hilo Sugar Plantation Company are:

	TSA
D—Cuttings from diseased plants	8.8
DT—Diseased cuttings given the HWT (52°C for 20 min.)	11.2
H—Healthy cuttings	10.3
HT—Healthy cuttings given the HWT	11.1

These results again demonstrate that chlorotic streak is controlled with HWT; yields from the diseased-treated cuttings were equal to those from the healthy or the healthy-treated cuttings.

All diseased or questionable planting material should receive the HWT prior to planting in order to avoid losses from chlorotic streak.

A replicated test including 19 commercial and breeding canes was installed in a poorly-drained area at Kailua to determine the reaction of each variety to chlorotic streak. As a result of the dry weather at Kailua, leaf symptoms of the disease have not developed.

Leaf Freckle

It has been demonstrated that leaf freckle is directly associated with subnormal soil fertility during periods of low temperatures. During the latter part of 1952, in cooperation with staff members of the plantations, of the Agronomy Department and of the Hawaii Island Substation, a series of observational tests were installed at Kohala Sugar Company, Honokaa Sugar Company, Paauhau Sugar Plantation Company, Hamakua Mill Company and Kaiwiki Sugar Company, Ltd., with various soil amendments and foliar applications of nutrients. The objective was to determine the elements which would assure the normal growth essential for the control of leaf freckle.

Due to the unusually dry and warm weather during the winter months of 1952-53, little or no leaf freckle

developed, thus making it impossible to draw any conclusions on the control of the disease from the experiments installed. However, in the majority of tests, a definite growth response was noted from the following treatments: phosphate, mud press, D-D mixture, lime and, in a few instances, A-Z mixture and Krilium.

Leaf Scald

The appearance of a number of cases of leaf scald (Hawaii) on the variety 44-3098 has caused some anxiety since in previous disease tests, the variety had shown a high degree of resistance to the disease. Under environmental conditions which are extremely favorable for a specific disease, it is possible for a resistant variety to be attacked; such is the case with 44-3098.

Two replicated tests were installed, one at the Pathology Plot where environmental conditions are normally dry, and the other at Olaa, where environmental conditions are normally wet. The purpose is to determine the resistance of the standard and newer canes to leaf scald disease.

Mosaic

In December, 1952, juice samples of Lahaina cane, expressed from healthy and from mosaic diseased plants, were frozen and shipped to Dr. A. H. Gold, Pathologist, University of California, to determine the size and shape of the virus molecule. On January 7, 1953, a photograph of the sugar cane virus molecule taken with the electron microscope was received from Dr. Gold. The virus particles were observed only in the juice samples from the diseased plants. The virus is rod-shaped, measuring approximately 15 x 630 millimicrons (Figure 16). A millimicron (mu) is one millionth part of a millimeter.

This is apparently the first time the size and shape of the sugar cane virus has been demonstrated, and Dr. Gold's cooperation in this project is greatly appreciated. The cane virus particle resembles that of the wheat virus which Dr. Gold recently demonstrated for the first time.

Pineapple Disease

Pineapple disease is frequently responsible for poor germination and retarded growth of cane, especially when cuttings are planted either under very dry or under cool, wet conditions. The disease has been effectively controlled by treating the cuttings with PMA or HPMA prior to planting.

Several cases were investigated where poor germination resulted when pineapple disease attacked the cuttings. To minimize future damage from the disease in these areas, it was recommended that all cuttings be treated with PMA before planting.

Pythium Root Rot

During the year, 10 new fungicides have been tested against Pythium root rot in young cane seedlings in

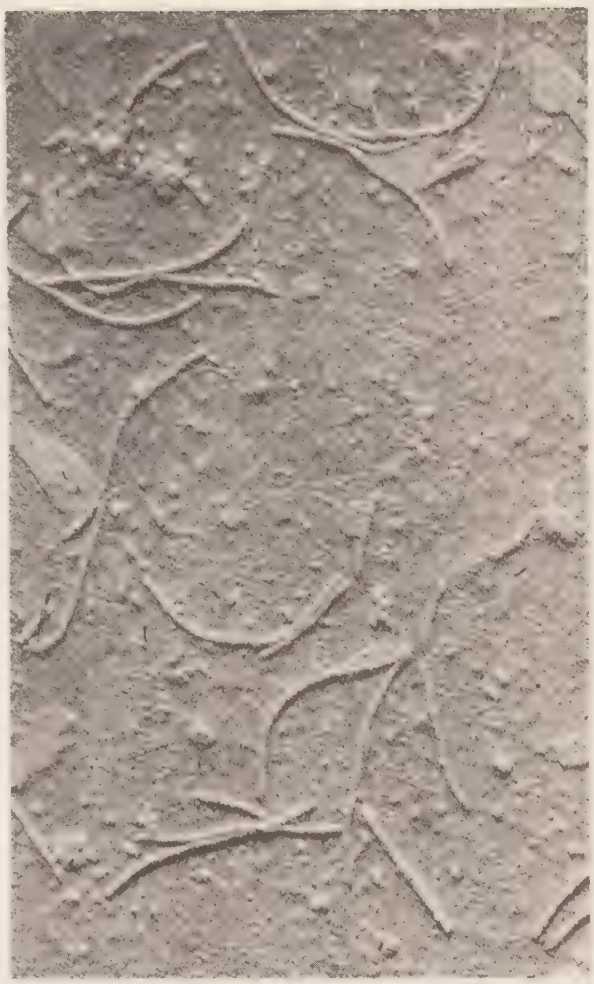


Figure 16. The sugar cane mosaic virus molecule, as seen under the electron microscope, is rod-shaped, and measures approximately 15 by 630 millimicrons. A millimicron (mu) is one-millionth part of a millimeter.

Figure 17. Composting bagasse, cane trash and mud press at Waipio. A mixture of these materials was well-composted and ready for field application at the end of six months.

an effort to improve on the control given by Phygon. Only copper-8-quinolinolate gave sufficient control to warrant further testing.

Search is continuing for organisms isolated from soils which exhibit antibiotic activity against the Pythium root rot organism. To date, several actinomycetes have been isolated which manifest a high degree of antibiotic activity against the root rot organism under laboratory tests, but not under field tests. New methods for testing antibiotic production by organisms are being employed. Roots of such "bait" plants as pineapple slips, sugar cane and corn, are exposed to the Pythium organism alone and in association with the organism producing antibiotic substances. The absence of root rot on the growing roots establishes the antibiotic production of an organism.

A modification of the Nutrient-Agar-Film method is giving considerable promise for testing antibiotic production by actinomycetes against the root rot organism in soils.

HUMUS FROM COMPOSTED BAGASSE AND TRASH

Aerobic decomposition of plant and animal residues is known to be more efficient than the anaerobic method. Organisms capable of breaking down organic matter are widely distributed in nature. Local organisms are as efficient as imported ones. The environmental factors, such as particle size, moisture, aeration, pH, temperature and the carbon-nitrogen ratio of the original material, determine the rate and completeness of any composting process, the final product being humus.

In field studies made at Waipio with members of the Agronomy Department and Waipio Substation, it was possible to produce a high grade compost at the end of six months from a 25:3:10 ton ratio mixture of bagasse, molasses and mud press (Figure 17). Under controlled moisture and temperature conditions, this time interval could have been reduced.

The disposal of cane trash presents a problem at some mills. A satisfactory low-cost method now being used at several plantations is to allow the piled trash to decompose under natural conditions. Usually the composting period is about 18 months long. However, turning the piles over once or twice hastens decomposition.

NITRIFICATION RETARDED BY D-D TREATMENTS

In laboratory studies, D-D mixture (1:3-dichloropropene and 1:2-dichloropropane mixture) applied to soil at the rates of 200, 400 and 800 pounds per acre foot, definitely retarded nitrification, the period of retardation lengthening as the rate of application increased. At the highest rate used, nitrification was completely inhibited for at least 16 weeks. The number and kinds of fungi in the soil were also markedly

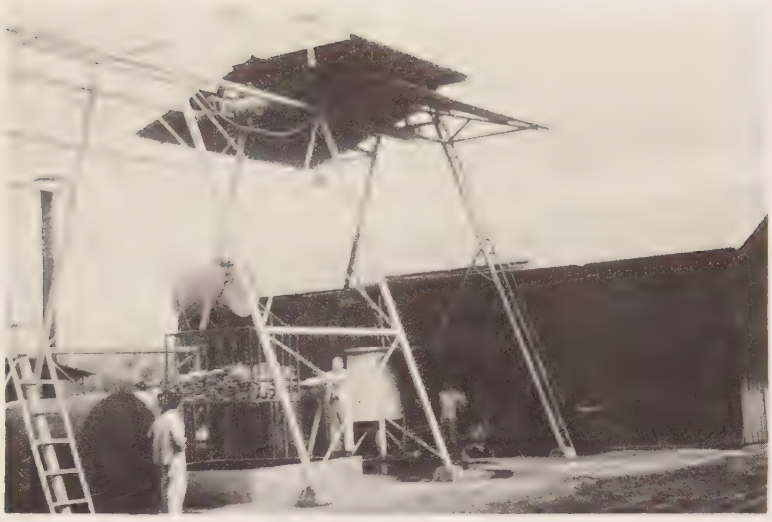


Figure 18. The hot-water unit at Waipio is constantly used to control diseases and insects in cane cuttings before they are shipped to plantations and regional stations. It is also used for treating cuttings at various temperatures and intervals in studies on germination and disease control.

reduced, the only species of fungi developing on plates being a *Trichoderma* sp. On the other hand, an increase in the total numbers of bacteria and actinomycetes was noticed at the highest rate of application. The effects of the lower rates on soil organisms were less marked.

The different fungi isolated from the D-D treated soils were found to have no effects on sugar cane growth. It was observed earlier that the growth, especially of 37-1933 plants, is stimulated when cuttings are planted in soils previously treated with 400 and 600 pounds per acre foot of D-D mixture.

GERMINATION STIMULATED BY HOT PMA TREATMENTS

The hot PMA treatment (HPMA) of cane cuttings prior to planting under either very dry or cool, wet conditions has aided greatly toward better germination and growth. Several plantations have installed hot-water units for treating cane cuttings at the mill where steam is available (Figure 18).

Other plantations are interested in a portable hot-water unit for treating cuttings at the seed source in the field in order to avoid the long hauls to and from the mill. Various types of heat generators for a portable hot-water unit are being investigated.

The results of a replicated test with 37-1933 at Waipio showed a slight stimulation in germination from the HWT at 50°C for 10, 20 and 30 minutes. The long heat treatments at 50°C for 90 and 120 minutes caused more injury to buds of top cuttings and of rapidly growing cane than to buds of the second and third cuttings and of cane making a slower growth. Similar results were also obtained in other germination studies.

HOT PMA BEST FUNGICIDE TO PROTECT SEEDPIECES

Of all the fungicides tested against rot-producing organisms, hot PMA (52°C for 20 minutes or 50°C for 30 minutes) has given the greatest protection to cuttings at the lowest cost. In addition to controlling pineapple disease, the treatment controls chlorotic streak and also insects which may cause poor germination. It also stimulates germination, shortens the closing-in period, and makes for little or no replant in plant fields. The procedure for determining the strength of PMA solutions was demonstrated to personnel of several plantations now using the HPMA treatment. Better germination has also been secured on plantations where a PMA solution is used as a dip or a spray on the freshly cut ends of the seed.

FACTORY

SUGAR LOSSES FROM FIELD THROUGH MILL BEING APPRAISED

A survey of all cane cleaner installations in the Islands has been completed in order to provide up-to-date design data as a background for an efficiency study of sugar losses incurred in the cane cleaning plant.

A study of these losses, as well as of losses which occur in the process of harvesting and transporting cane, is being made at the Puunene mill of H C & S. The first phase of this investigation covered sugar lost as juice from damaged cane.

Fifty replicated tests established at 5.7 per cent the total sugar loss in cane between its standing in the field after burning and its arrival at the crusher. Of this loss, 2.9 per cent occurs in harvesting and transporting, and 2.8 per cent in cleaning. A considerable portion of the loss in cleaning is attributable to damage incurred in previous operations.

In determining the losses, a new technique has been developed in cooperation with the Department of Experimental Statistics which appears promising for use in agricultural studies. The procedure emphasizes the extreme value of good experimental design to ensure significant results. It makes possible the rapid handling of samples of cane up to 1000 pounds (Figure 19).

1. The entire cane sample is reduced in an ensilage cutter and subsampled continuously in the operation.
2. A small sample of the subsample is disintegrated with a definite amount of water in a new type of machine developed at the Experiment Station.
3. The extract is analyzed for pol, and the fiber is washed and dried for fiber content.
4. Losses are based upon the pol to fiber ratio.

The general appraisal of other sources of sugar losses will include those due to burning, to cane left in the field, to cane lost on the road, to stockpiling, to cane lost through the rock gap of the cleaner, and to cane which is carried out with the trash.

Tests similar to those being made at H C & S are planned at other locations.

RADIOACTIVE COBALT TESTED AS A BAGASSE WEIGHING DEVICE

In cooperation with the Department of Physiology and Biochemistry, the method of measuring materials on a moving belt by means of gamma rays from Co 60 was tested and checked on the sugar conveyor at the Nawiliwili bulk sugar warehouse. The amounts of sugar moved by the belt checked the known load weights within the expected statistical errors of counting gamma rays. As there was no evidence of drift or other limitation which would prevent the development of this method for weighing bagasse in mills, new instruments are now on hand to put this system into practice.

WASHING OF CLARIFIER SETTLINGS INVESTIGATED

A pilot-scale counterflow washer for de-sugarizing clarifier settlings was constructed and operated on an experimental basis at the Ewa factory during the 1953 season. The washer is designed to replace the vacuum rotary filter which is presently used to remove sugar from the clarifier settlings before they are discarded.

Results of tests with the pilot model indicate that an adequate commercial unit would have to be quite large, approaching a clarifier in size. The quantity of water necessary to wash the mud is considerably greater than that used by the present vacuum filter. Although data for a detailed economic study are not yet available, these factors make it appear likely that counterflow washing will have no advantage over the present system.

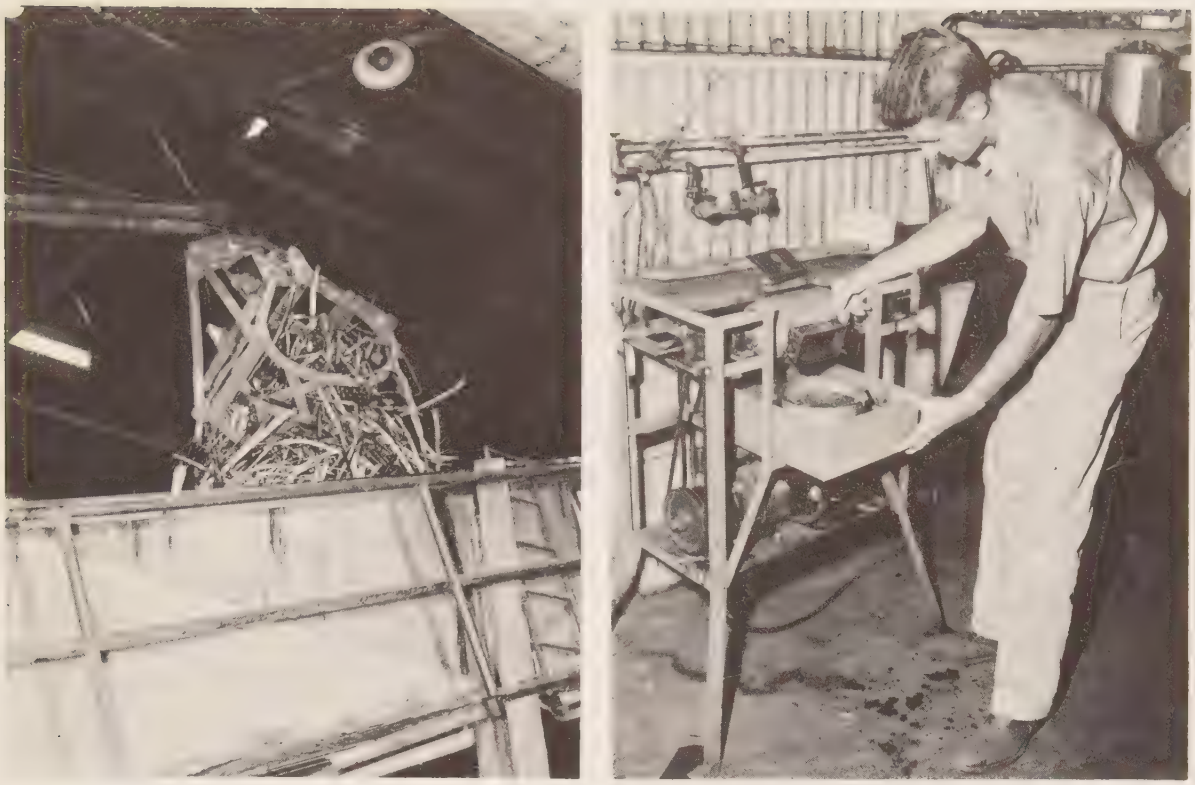


Figure 19. In determining sugar losses, a sample of cane is lifted from the mill carrier, shown at the left. After being chopped with an ensilage cutter, the cane is disintegrated in the new type of machine, developed at the Experiment Station and shown at the right. Losses are based upon the pol to fiber ratio.

ION EXCHANGE MEMBRANE PROCESSING UNDER STUDY AT IONICS, INC.

A program of research work on the processing of sugar liquors by means of the ion exchange membrane technique is under way at the laboratories of Ionics, Inc., at Cambridge, Massachusetts. The work is sponsored jointly by the Hawaiian Sugar Planters' Association and Godchaux Sugars, Inc., of Louisiana. This new method offers promise of considerably lower costs than conventional ion exchange procedures.

DISSOLVING POTASSIUM CHLORIDE CRYSTALS IN MASSECUITES WITH MOLASSES

In an effort to prevent the crystallization of potassium chloride in low grade massecuites, cooperative work has continued with H C & S.

Pilot-scale boilings have been conducted by the staff at Puunene, using low ash Olaa molasses and "B" molasses in which the cations had been replaced by ammonium in an ion exchange cycle. Commercial boilings were also made with the Olaa molasses.

Results with Olaa molasses were not as satisfactory as those obtained in the laboratory two years ago. This is partly due to the fact that the potassium content of Olaa molasses has doubled because fertilizer usage has increased.

Results with ion exchange molasses in the ammonium cycle are promising due to the low viscosity of the treated molasses. Investigation is continuing not only on ammonium cycle, but also on completely deionized molasses.

MOLASSES EXHAUSTIBILITY TESTS DISCONTINUED

Routine molasses exhaustibility tests have been discontinued and estimations are now made on the basis of the reducing substance to conductivity relationship. Studies made on the theoretical exhaustibility

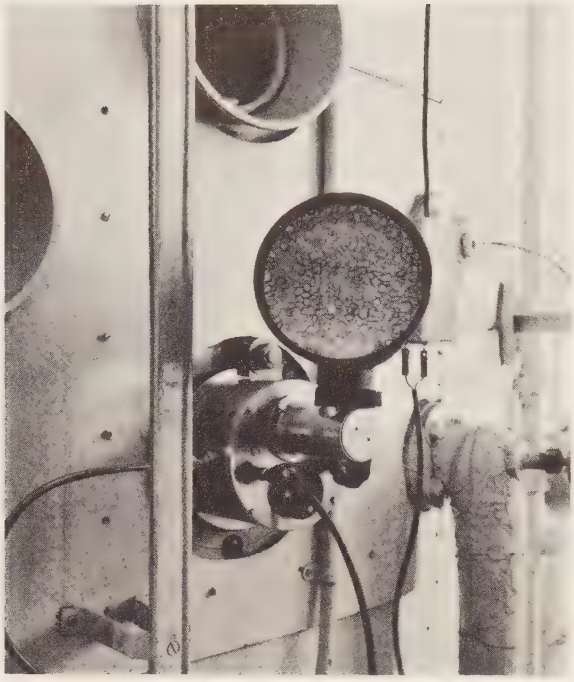
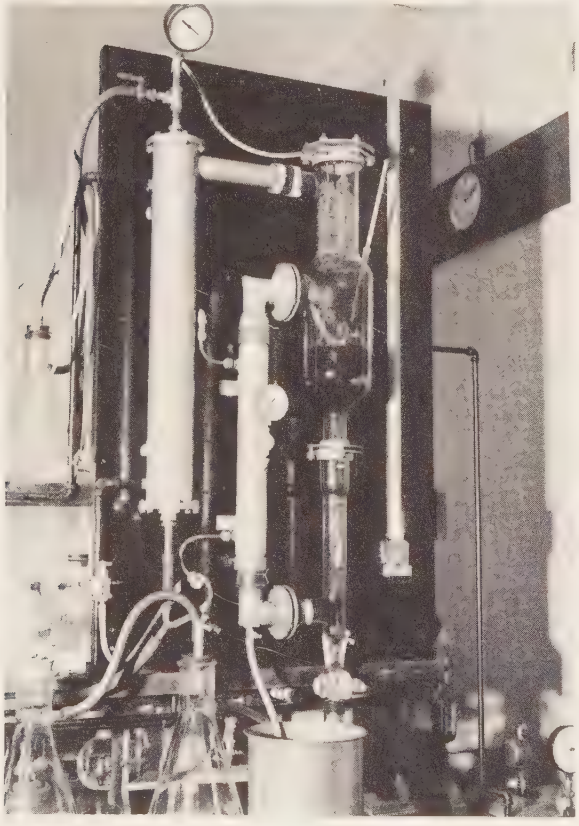


Figure 20. Crystal projector for vacuum pan installed at Waialua on an experimental basis.



of molasses in which all the cations have been replaced by ammonium in an ion exchange cycle, show that this substitution results in lower molasses purity.

PAN CRYSTAL PROJECTOR INSTALLED

On an experimental basis, a Preissler crystal projector has been installed on the seed pan at Waialua Agricultural Company, Ltd. The projector enables the panman to observe the sugar crystals in the pan without having to withdraw a sample by means of a proof stick. The instrument appears to be a useful aid to sugar boiling (Figure 20).

EVAPORATOR SCALE DIFFICULT TO REMOVE

In laboratory tests, Versene (sodium salt of ethylene diamine tetraacetic acid) has proved effective in removing evaporator scale when used following treatment with caustic soda.

However, a commercial trial made at Kahuku Plantation Company resulted in only partial scale removal. With the very hard scale found at Kahuku, the silica sticks very tightly, and investigation has shown that Versene, which is a sequestering agent, tends to leave silica untouched. It may be that Versene will prove more effective when used with some other silica-removing agent.

Scale inhibitors were the subject of a season-long study in cooperation with Kahuku. Investigations failed to uncover any compound which was both effective and economically sound when used on this very resistant scale.

The problem is now being studied in the laboratory with the use of an experimental unit which permits appraisal of scale formation on a single tube (Figure 21).

SUGAR ASH NOW DETERMINED CONDUCTIMETRICALLY

Analysis of ash on all sugar samples is now made by conductimetric measurement. This method saves considerable time and is recommended for adoption by factory laboratories.

Figure 21. Experimental apparatus for studying evaporator scale used in the laboratory at the Experiment Station permits appraisal of scale formation on a single tube.

INSECTS

No new insect pests of sugar cane have appeared in Hawaii during the year and damage by the established pests has been light.

LEAFHOPPER THREATS TO HAWAII

During January, a commercial plane from Fiji was found by inspectors to contain living Fiji sugar cane leafhoppers. These were destroyed and it is not believed that any escaped. As this insect is the carrier of Fiji disease, and as this is the second time within 12 months that a plane has arrived at the Honolulu Airport with living individuals of this species, the threat of its ultimate invasion into Hawaii by this means points to the need for frequent surveys into the Pearl Harbor region for evidences of establishment. Light trap surveys have continued during the year. Many thousands of insects have been caught and examined; but no Fiji leafhoppers have been discovered.

In July, 1952, a leafhopper, new to Hawaii, was caught in our light trap at Ewa. During succeeding months, many more were caught. In May, 1953, a survey of grass and cane near the trap revealed the presence of large numbers of this insect in manienie grass. It was also found several miles from the trap. Specimens were sent to the U. S. Bureau of Entomology and Plant Quarantine, Washington, D. C., and were promptly identified as *Deltocephalus sonorus* Ball. This leafhopper is known to occur in grass, sometimes in great numbers, in the southern sections of the United States, from Florida to California. Some concern was felt that it might attack sugar cane, since grass is its natural host. On September 9, it was found at Waialua, indicating that it is spreading rapidly on Oahu. Fortunately, however, there has been no indication as yet that it will attack sugar cane. The insect is shown in Figure 22.

Figure 22. The new grass leafhopper *(Deltocephalus sonorus)* now established on Oahu is one-eighth of an inch long.

PARASITES NAB ARMY WORMS AND APHIS

During April and May, the common army worm *Laphygma exempta* appeared in small localized spots on the island of Hawaii. Entomologists examined these early in June, and reported finding the caterpillars, or traces of their recent presence, on 11 of the 13 plantations. In no case did any infestation develop

into extensive colonies, and in all cases parasites, readily found, effectively eliminated the outbreaks. No army worms have been seen by the entomologists or reported by plantation personnel on any of the other islands.

The sugar cane aphis has developed in noticeable numbers in small areas in the Territory during the year, but in no case has any infestation been prolonged or extensive. In one case at Mountain View at Olaa, an outbreak was quickly eliminated by a fungus disease. Usually aphis infestations are promptly suppressed by ladybirds and other natural enemies.

THE ARGENTINE ANT CONTINUES TO SPREAD

The Argentine ant continues to spread slowly. Though present on Oahu, Maui and Hawaii, it is still unrecorded on Kauai. During July, it was reported so numerous on some areas at Waialua that it was a nuisance to workers. The gray sugar cane mealybug *Trionymus boninsis* has increased somewhat in all places where the ant has become abundant. However, as the ant has not seriously affected the natural enemies of this mealybug, serious developments are not anticipated.

BENEFICIAL INSECTS SENT TO OTHER COUNTRIES

During the year, the department has sent to several countries, at their request, the following beneficial insects:

Rodolia cardinalis (a ladybird) to American Samoa for control of *Icerya seychellarum,* a mealybug pest of breadfruit.

Microceromasia sphenophori (our cane borer parasite) to Bolivia for trial on a related cane borer in that country.

Campsomeris marginella modesta (Scolia manilae) to British Samoa to aid in the control of a beetle *(Adoretus versutus)* that badly damages cacao.

Anagyrus saccharicola (pink mealybug parasite) to Queensland for control of the pink mealybug in Australian cane fields.

MEALYBUGS NOT A CANE THREAT

The two species of mealybugs that normally occur on cane in Hawaii are generally so well controlled by natural enemies that they have long been considered and listed as minor sugar cane pests. We doubt if sugar losses caused by them are great enough to be measurable. However, in experiments conducted by entomologists in South Africa, some but not all of the tests indicated that cane grown from mealybug-infested seed grew slower and yielded somewhat less sugar when harvested than cane grown at the same time from uninfested cuttings.

To determine what effect, if any, mealybugs may have on the germination of seed cane and subsequent cane growth, an exploratory test was set out at Waipio in May by entomologists, in cooperation with the Waipio Substation staff. Clean seed and mealybug-infested cuttings of 37-1933 and 47-4991 were planted. In the early stages of growth, more shoots appeared from the mealybug-free cuttings than from the infested cuttings. One hundred and fourteen days after planting, no conclusive differences could be detected in favor of the mealybug-free plantings.

MECHANIZATION

During the past year, the Agricultural Engineering Department has continued testing harvesting machinery and experimenting with new developments. Thinking in terms of the final results and the permanency of the harvesting system, the program has been divided among short, medium, and long range developments. The elimination of the push rake and the grab has been accepted as an ultimate goal because neither can handle cane without damage to both the field and the cane. However, because they are rugged, simple and cheap, they have a great deal of operational and economic appeal.

A machine which does nothing but cut cane has been considered a short-range development since, with its operation, full use of push rakes and grabs is required. In this same group of projects are the irrigated cutter-only, the Laupahoehoe cutter and the side cutter bar. The future development of these machines will be determined in 1953.

In the medium-range group are the side-mounted cutter-windrower and the cutter-transport, or wide track cutter-windrower. The use of the side-mounted cutter-windrower has increased to some degree; all of the development during the past year has been handled by three plantations. A new set of drawings for this machine is being made. The cutter-transport is a new project aimed at adapting the cutter-windrower type of machine to the wetter areas. This type of machine is a major step in eliminating the push rake.

In the long-range group are the cutter-loader and the portable dry cleaner. All the experimental and development work on these machines is aimed at establishing a system which eliminates the use of both push rake and grab, except in marginal areas.

Minor developments during the year include the following items: as a possible improvement in grabs, experimental work was done on a small size hydraulic grab; the use of a rotary hoe in preparing the ground for planting has become established at two plantations; one type of plastic proved to be successful for lightweight irrigation flumes.

"CUTTER-ONLY" FOR IRRIGATED CANE REDESIGNED

This one-line, V-type, self-clearing, cutter-only machine was described in principle in the 1952 report. Because of consistent difficulty in cutting through heavy tonnage and through unburned cane, a new cutting-dividing assembly was designed and built (Figure 23). The major changes in the design are as follows:

1. The single 21- to 23-inch tip diameter ground knife was replaced by two 11- to 13-inch tip diameter knives which give a 21- to 23-inch total width of cut. The vertical knife can dip down between the two knife housings, thus eliminating the lifter on each side of the single ground knife housing.

2. The tip diameter of the vertical-dividing knife was increased from 34 to 48 inches with a more rugged design.

3. The power from the auxiliary engine was brought forward along one side, rather than close over part of the prime mover which had reduced accessibility to the prime mover.

4. A new assembly using a final chain drive to each knife was designed, built, and installed. This drive has absorbed considerable abuse without failure, proving rather definitely that the shock absorbing characteristic of roller drive chain is important as the final drive to a ground cutting knife.

The objective of the machine is to make possible better, less expensive ratoons, to improve the quality of cane delivered to the mill, to increase production of push rakes and grabs, and to make possible fewer field roads.

This machine is also a first step in a possible har-

Figure 23. At the left, the front view of the irrigated cane cutter shows the double ground knives, vertical or dividing knife, and side chains. At the right, the cutter is shown in operation.

vest system using single operation machines. The cutting procedure, developed in the field, is to cut every other line, going back to cut out the missed lines, leaving a compact two-line windrow in every other furrow.

This type of machine has cut three-fourths to one acre per hour under reasonable conditions. Its ability to absorb abuse in rocky conditions has been outstanding. The quality of work done and the production accomplished are best on reasonably level land with soil which is not extremely mellow. On slopes with very mellow soil, it is difficult to keep the prime mover traveling on the ridges. Also, up to this present time, the operator must have visibility if he is to follow the furrow accurately, as he must for quality work.

"STOP-GAP" CANE CUTTERS IN ACTION

During the past year, the term "stop-gap cutter" has come to describe a machine which would cut only and which could be made immediately available to improve cutting.

Laupahoehoe Sugar Company developed a light unit on a D-4 tractor (Figure 24). It consisted of a thin diagonal shear blade mounted on the right side of the tractor for the ground cutting. The section between the row being shaved off and the adjacent row was cut by a 74-inch tip diameter free-cutting vertical knife. The height, tilt, and suction of the ground cutting blade and the cutting height of the vertical knife were controlled by the operator.

Additional development was recommended to give at least partial self-adjustment of the ground cutting blade.

A new mounting of the ground cutting blade was designed and built so that the blade could be fully or partially floated, or rigidly controlled. Other changes were aimed at making the machine more nearly a production unit.

Laupahoehoe has been operating the machine since May 15. They have found the ground cutting blade to be partially self-adjusting, depending on conditions. A light push rake is used to shunt the cut cane out of the way and into windrows.

The production has averaged 0.40 acres per hour, based on actual operating time. The quality of work done has been generally better than is possible with the "V" cutter, particularly on steep side slopes. Normal operation is to cut against the recumbency pattern, and the satisfactory cutting possible in variety 44-3098 has been of considerable value.

The double ground knife side cutter bar built in

Figure 24. The Laupahoehoe cutter is shown with both knives in the lifted position.

1952 was made available to Hamakua for use this year as a production unit. They have found that the double ground knives which turn toward each other on the leading side are considerably more vulnerable to rock damage than is the case with a single knife.

Satisfactory operation has been reported with an average production of 39 gross tons per hour based on actual operating time.

SIDE-MOUNTED CUTTER-WINDROWERS IN PLANTATION USE

Lihue expanded the use of the side-mounted cutter-windrower by increasing the number of their machines from two to four. They have been operating two machines in irrigated cane, which is a new production operation for the industry. Their outstanding recent development was the discovery that they could standardize on one machine since the arrangement of the pickup assembly for irrigated cane is also satisfactory for cutting unirrigated cane. The staggered arrangement of the pickup roll for irrigated cane has the advantage of being easier to maintain.

The machines at Hamakua and Kaiwiki have also given good results this season. It must be remembered that 1953 has been a good season for cane cutters because of the good burns. A wetter season would emphasize the importance of good maintenance and the necessity for continued development.

Average productions of 30.5 net tons per hour to 47.5 gross tons per hour have been reported for this year.

CUTTER-WINDROWER FOR WETTER AREAS UNDER CONSTRUCTION

A cutter-transport project, combining the development of the side-mounted cutter-windrower and the cane buggy, is similar to the side-mounted cutter-windrower, but is equipped with the cane buggy type of prime mover instead of a standard track-type tractor with an outboard wheel. One engine has been used to supply all the power. The HSPA-type of cane buggy prime mover was used because it gives maximum clearance under the elevating conveyor and maximum accessibility to the prime mover and conveyor assemblies for maintenance purposes. Maximum flexibility built into the elevating conveyor assembly allows the cutting-pickup assembly to follow the ground more closely on uneven terrain. Because of the width and length of the tracks, the ground pressure is lower than it was with earlier machines (Figure 25). Some low alloy structural steel was used and 10 aluminum track shoes are being tried in the hope of reducing weight. This machine is nearly ready for preliminary field testing.

Figure 25. Each side of the cutter-transport is illustrated to show the two tracks of the prime mover. In the left-hand picture, the track is under and at the outer edge of the elevating conveyor, while in the right-hand picture, the track is directly beneath the single engine which is located immediately behind the operator.

Figure 26. At the left, the direct-mounted cutter for unirrigated cane is being operated as a cutter-loader at Laupahoehoe. At the right, cane is being loaded at Grove Farm. The 36-inch saws are installed so that they extend up through the elevating conveyor deck for parallel-flow cutting.

Figure 27. The eight-line windrow cut and formed by the direct-mounted cutter is being loaded into the cane buggy by the Thomson loader.

CUTTING-LOADING UNIRRIGATED CANE

The direct-mounted, two-way cutter was continued on an experimental basis as a cutter-loader and as a continuous discharge windrower for use in unirrigated cane. The present machine provided valuable information relative to the best type of engine design, the problem of handling trash, the direction of the flow of cut cane, the correct gauging of cutting assembly side-trimming knives, the question of double versus single ground knives, the problem of functioning on side slopes and of loading directly into a transport unit (Figure 26). This two-way machine was effective for cutting 20-foot firebreaks in the heaviest cane. The cut cane is discharged evenly into the adjacent uncut cane and does not interfere with cutter operation after the burning.

Since it was possible to cut and windrow continuously at travel speeds up to 3.9 miles per hour, the possibility of loader equipment which would load effectively from a light windrow was suggested. Work on this development clearly showed that a continuous discharge cutter can be substantially smaller and less expensive than any machine such as the cutter-windrower which accumulates a load of cut cane.

LOADING CANE FROM LIGHT WINDROWS

By using the 10-foot adjustable cross-conveyor on the direct-mounted cutter and by cutting in a pattern, it was possible to combine the cane of five to eight lines into a compact windrow, with the lines. The Thomson (Louisiana) Loader was equipped with a light push rake with gage wheels placed in such a way that the grab could load directly from the rake. The loader pushed and loaded the windrow into the cane buggy alongside (Figure 27).

This type of operation was successful as a system but the production was not adequate. The average loading rate was 14 tons per hour. The density of the loads was 13.2 pounds per cubic foot as compared to 7.3 pounds for the same cane direct-loaded from the cutter into the cane buggy. Very little brooming up was required behind the loader.

A push rake-loader unit for production should be track-type and have about double the grab and reach capacity of the Thomson machine. Its use should send cane of substantially better quality to the mill than a standard push rake can deliver. Its advantage should be most outstanding in wet weather.

Figure 28. The left-hand picture of the portable cane cleaner shows the clean cane elevator which can be mounted at either end of the cross-conveyor on either side of the machine. The elevator angle is adjustable from horizontal to nearly vertical. Note the pile of extracted trash under the cleaner. When this much has accumulated, the cleaner is moved ahead about 10 feet. At the right is shown a windrow of extracted trash from unburned cane, variety 44-3098, at Olaa. The amount of short cane lost in the trash and the leaf trash left with the cane have not as yet been determined conclusively. These tests will be made after more mechanized "bugs" have been eliminated.

PORTABLE DRY CLEANER PERFORMS WELL IN THE FIELD

The portable cane dry cleaner, described in the 1952 report, was first field-operated on Hawaii on December 4, 1952, using grab-harvested and cutter-cut cane. The initial operation indicated the soundness of the principles on which the machine was based (Figure 28).

After some minor changes were made, a series of tests were run at the Olaa mill, using soaking wet, grab-harvested cane to investigate the possibility of the peg tooth principle as a leaf trash separator in mill cleaning plants. The results of these tests, plus the low initial and maintenance costs, were convincingly in favor of the peg tooth drum-blower principle as compared to conventional Olsen rolls. A summary of these results is listed as follows:

	Knives In	Knives Out
Total leaf trash per cent gross cane..	22.2	22.4
Rate of gross cane cleaned per hour..	41.8 tons	48.9 tons
Rate of net cane cleaned per hour....	32.6 tons	38.0 tons
Mill trash per cent net cane.....	5.28	4.21
Cane in trash per cent net cane.....	2.29	3.01
Per cent trash extracted of total leaf trash in field cane.....	80.2	85.8

The "cane in trash per cent net cane" was high; however, it was obvious that design changes could correct this. The comparison between "knives in" and "knives out" emphasizes the possibility of doing some cutting up on a cane cutter and omitting knives in the cleaner.

This machine was so designed and constructed that the separated leaf trash, as well as the clean cane, would be conveyed out of the machine and elevated by conveyor into transport units. More extensive field operation emphasized the difficulty of screening all of the leaf trash out of the air blast and conveying it out of the machine. This trash problem, combined with lesser problems which were retarding production operation, called for a major redesign to bring about the following changes:

1. Removal of the leaf trash conveyor and elevator.
2. Increase of clearance under the feed conveyor to 4 feet 4 inches for the leaf trash windrow.
3. Reduction of the carding elevator slope from 55° to 45°.
4. The shape of the main frame was changed to allow a lower mounting of the clean cane cross-conveyor. This allows for a greater drop of the clean cane away from the drum and dividing roll.

5. A completely new and radial type of dividing roll was installed and relocated.

6. Four more rows of teeth were added to the peg tooth drum and the teeth were spaced so as to intermesh with the lugs on the carding elevator conveyor.

7. Modifications were made of chain lugs and cross-slats, air nozzles and knife cutter bars.

Initial operation after changes showed substantial improvement in production and continuous operation. By feeding the machine from a windrow of harvested cane, a windrow of leaf trash is left on the ground. The productiveness and capacity of this size of machine, and the efficiency of trash extraction at different levels of production are being determined.

EXPERIMENTAL HYDRAULIC GRAB SUCCESSFUL

Hydraulic equipment developed by Bucyrus-Erie for a three-eighths yard Hydrocrane had several features which appeared to be outstanding: 1) the use of pressure up to 6000 pounds per square inch reduces the sizes of cylinders and lines; 2) all equipment, such as buckets and grabs, is designed to open by weight so as to require only single acting cylinders; and 3) the single hydraulic line wraps on a tag-line type of reel and also serves as the tag-line (Figure 29).

A set of this equipment was procured and installed on the Waipio Substation 2/5 yard Quickway crane. The hydraulic pumps were mounted so as to be driven by the crane engine. The closing line lever was disconnected from the drum clutch mechanism and connected to the hydraulic valve. The tag-line type of reel for the hydraulic line was mounted on the boom. The forked grab was rebuilt using the Bucyrus-Erie head assembly and replacing the solid pointed tines with tubular tines. The grab width was increased from 30 to 48 inches and the spread was increased from 5.5 feet to 7.1 feet, and a headpiece was added. The relief valve was set at 3500 pounds maximum pressure. The peak pressure while closing the grab on cane is about 3000 pounds.

Waipio Substation has kept the equipment operating and reports satisfactory service; the operator prefers the hydraulic to the cable-closing grab. The grab weighs 1430 pounds and has a capacity of 700 to 1000 pounds of hand-cut cane.

On the basis of this operation, a 12.5-foot hydraulic grab has been designed and the availability of the necessary auxiliary equipment is being determined.

Figure 29. Experimental hydraulic grab.

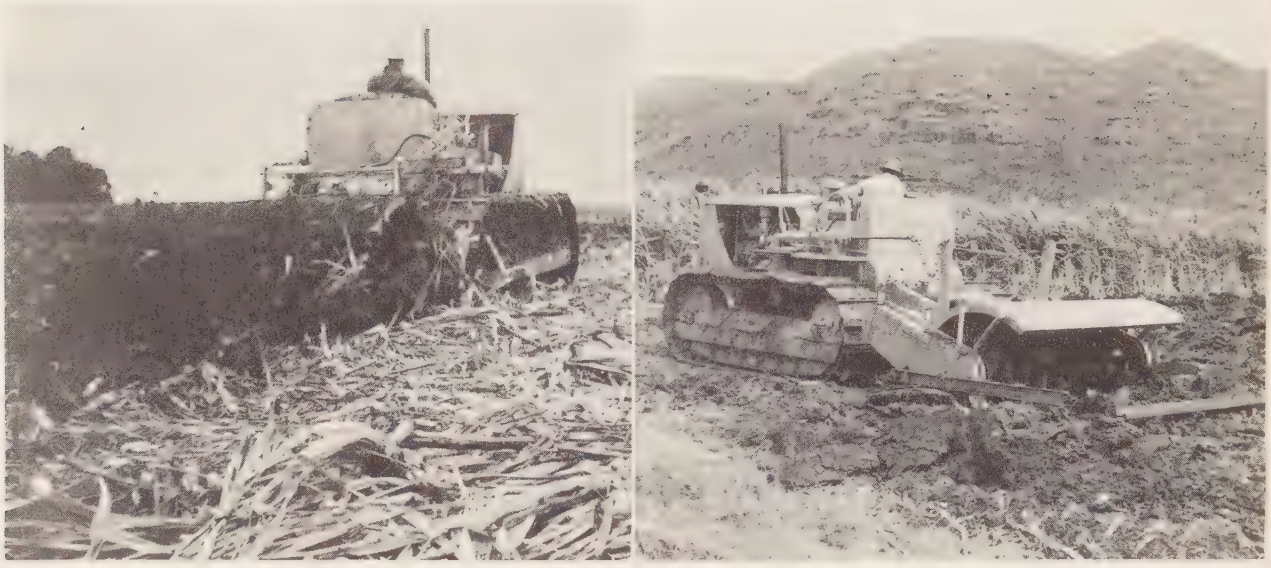


Figure 30. At the left, the Howard rotary hoe is being used at Hilo Sugar as first operation in ground preparation for planting. At the right is shown the Kekaha "Tillivator" which is based on the Howard rotary hoe.

ROTARY HOE A VALUABLE TILLAGE IMPLEMENT

Rotary hoe tillage is finding a place in the preparation for planting (Figure 30). A unit, based on the Howard machine but manufactured to plantation specifications, is used at Kekaha in conjunction with a Storey gyrotiller plow for preparation of heavy soils.

Hilo Sugar recently purchased the Howard "Rotovator" rotary hoe which was procured in 1951 for experimental use. By eliminating disc harrow operations and using only the rotary hoe and a plow, they have found it possible to improve seed bed preparation substantially.

IRRIGATION FLUME DESIGN AND MATERIALS

In seeking a material for irrigation flumes, Ewa has tried, on a limited basis, the different available types of plastic material and has found Panelyte the most promising (Figure 31). The field testing of Panelyte became a cooperative project, in that the Department of Agricultural Engineering purchased the mold recommended by the manufacturer to give the material a permanent semi-circular shape, and paid the nominal cost of laboratory analysis to determine the rate of deterioration of the material.

Ewa installed 4400 feet of Panelyte flume to irrigate a 36-acre area. The lengths of flume lines varied from 300 to 850 feet with slopes ranging down to 0.30 per cent. The area was harvested during 1953.

Results and Conclusions

Material:

1. Panelyte was not essentially damaged during installation, while in use, or by removal at time of harvest.
2. The deterioration of Panelyte after two years was too slight to measure.
3. The following thicknesses proved satisfactory:
   18″ and 24″ flume—3/64″ thickness
   30″ and 36″ flume—1/16″ thickness
   48″ and 60″ flume—5/64″ thickness

Fabrication:

1. As the flume could be formed as laid in the field using flat sheets and a center cross-tie, it was determined that a mold was not necessary.
2. A sock-type outlet was used, but most of the types now used with aluminum flume could also serve.

Installation and Operation:

1. This flume could be installed and used on a slope as low as 0.50 per cent.
2. A slight overlapping of sections, with no seal material, gave a no-leak joint.
3. As compared to other types of outlets tried at Ewa, the Wailuku sock gave minimum erosion in the furrow at the outlet. A butyl rubber sock gave the best result.
4. The low fabricating cost puts Panelyte in line with other lightweight materials as to total cost.

Figure 31. This 33-inch Panelyte flume is shown on a 0.35 per cent grade.

VARIETIES

NEW VARIETIES AFFECT AGRICULTURAL PRACTICES

The introduction of a vigorous new variety may exert either a favorable or an unfavorable effect upon farming practices. Examples of both categories are to be found in the history of the industry.

During the depression years with their low sugar prices and quota restrictions, the introduction of more vigorous varieties was followed in some instances by a deterioration in farming practices. Because the new variety was better able to compete with weeds, control measures were sometimes permitted to relax unduly. Because the new variety was able to endure makeshift harvesting procedures that would have killed out the older varieties, these makeshift procedures became standard practice. In the absence of replacement for H 109 and Yellow Caledonia, the survival of the industry would undoubtedly have demanded an earlier and a more intensive attack upon the problem of developing better harvesting methods.

Fortunately, the effect of a new variety upon farming practices is more often beneficial than harmful. Control of manienie and Panicum repens seemed economically hopeless in certain areas until the advent of new varieties with their greater vigor and higher yield potential, together with the development of improved herbicides, helped to turn the tide of battle. In many instances, too, an appreciation of the capacity of the new variety for response to improved farming practices has led to an intensification of effort in this direction.

Even the best of varieties can be reduced to mediocrity by failure to provide any one of the many requirements for normal growth. In the light of this fact, the futility of any course that attempts to substitute improved varieties for sound farming practices becomes obvious. The returns on the investment in breeding will be determined in large measure by the extent to which improved varieties can provide incentives toward a better agriculture.

CANE COLLECTION PROJECT SPONSORED BY I.S.S.C.T.

At the Eighth Congress of the International Society of Sugar Cane Technologists in the British West Indies, Dr. John N. Warner, Senior Geneticist, was named Chairman of the Standing Committee on Varieties. The primary project of this Committee is to attempt to implement the establishment of a world collection of original sugar cane varieties. This project is intended to provide not only for the preservation of material in existing collections, but for further collection and study of original sugar cane varieties and their wild relatives. The Resolution passed at the Congress calls for financing by the cane sugar producers of the world on a pro rata basis. It is hoped that some additional outside support can be arranged to establish the project and to insure its operation through the initial decade.

W. W. G. Moir acted as the "spark plug" for the project prior to, and during, the Congress. He is continuing his work as Vice-Chairman of the Committee. The first two problems to be met are financing and the selection of a suitable site.

Following the Congress, Dr. Warner visited the several suggested sites for the collection. These were (1) Tobago, an island northeast of Trinidad, B.W.I.; (2) Panama; (3) Turrialba, Costa Rica; (4) Papaloapan and Tapachula, two sites in Mexico; and (5) The Isle of Pines, south of the western end of Cuba. As a result of on-the-ground surveys, Turrialba, Costa Rica, the location of the Inter-American Institute of Agricultural Sciences, was considered to be the most desirable. Negotiations are now under way to secure the necessary permission from the Government and the sugar industry of Costa Rica. The collection would be housed on property belonging to the Institute.

The financing aspects of the project are also being studied. Members of the Committee have been asked to study the preliminary proposals of the scope and activities of the project and its tentative budget.

CANE BREEDING PROGRAMS VISITED IN CARIBBEAN AREA

Following his attendance at the Eighth Congress of the International Society of Sugar Cane Technologists, Dr. Warner visited cane breeders in Colombia, Mexico, Puerto Rico, Florida and Louisiana. While at none of these places were crossing operations actually taking place, the visits provided an opportunity of seeing seedling testing programs and of exchanging ideas on techniques and philosophies with the personnel responsible for the breeding programs.

While in Jamaica, a brief glimpse was had at their seedling program. While no crossing is done there, fuzz is imported from the Barbados Central Cane Breeding Station by the Sugar Research Department of the Jamaica Sugar Manufacturers' Association. The germination and early handling of the seedlings are accomplished at the experiment station, but lacking a network of variety testing stations, the original seedlings are apportioned among cooperating estates for selection and testing. This program has only recently been initiated. Formerly the Barbados Station sent to Jamaica several hundred first-year selections for distribution and testing. The new scheme has the advantage of working with a larger number of seedlings and of having all stages of selection under Jamaica conditions. Also, crosses can be tailor-made for Jamaica where mosaic disease strains are different from those in Barbados.

The breeding program of the Barbados Central Cane Breeding Station is one of the two oldest in the world. The other, at Pasuruan, Indonesia, is reported to be still active although drastically curtailed from the level of pre-World War II activities. In Barbados, one finds an excellent program under way, financed partly by the Government and partly by the various sugar producing areas of the B.W.I. and several adjacent countries. In the absence of pressure of higher labor costs, techniques are much the same as they were in Hawaii during the 1920's. The normal breeding program is supplemented by cytogenetics activities and by an exploration of the usefulness of selfing as a breeding tool.

The breeding work at Palmira, in the Cauca Valley, Colombia, is on a relatively small scale, but has a wealth of interesting breeding material. Unfortunately, the program suffers from inadequate liaison between the Station and the industry in the matter of testing. Lacking an effective association, the producers and growers can do little toward helping to provide guidance and direction for the breeding program of this government station.

In Mexico, a breeding program is just getting under way at Tapachula under the sponsorship of the Union Nacional de Productores de Azucar. The environment at the station seems quite suitable for breeding. The main drawbacks of the present program are the limited breeding collection, the confusion of variety mislabeling, and the presence of mosaic throughout the collection. The effort is to be commended, however, as the Mexican industry has long been in need of a variety improvement program.

The sugar cane breeding program in Puerto Rico is now centered at the University Experiment Station, Rio Piedras. While none of the P.R. varieties has as yet attained widespread commercial cultivation, there are several which have been spread experimentally. The breeding program appears to have a reasonable degree of cooperation with the industry in the matter of testing. There is a small private breeding program, located at Central Aguirre, designed to provide new varieties for a group of three Centrals on the southern coast.

Florida has three separate breeding programs. The U. S. Sugar Corporation, the Florida Agriculture Experiment Station, and the USDA Station at Canal Point are all breeding canes for Florida conditions. However, the last program is primarily aimed at the Louisiana industry. Breeding is also conducted at Palm Farm Research Station adjacent to Canal Point, for Cuban interests. In breeding for Florida, the U. S. Sugar Corporation has the most intensive program and appears to have accomplished more than the others in providing better canes for specific conditions. All of these stations work under the handicap of an unfavorable environment for conducting breeding. Poor tasseling conditions, low temperatures, hurricanes and floods are frequent hazards which can seriously disrupt crossing operations.

Sugar cane varietal improvement in Louisiana stems from two sources. The largest and oldest program is that of testing seedlings from the USDA breeding program at Canal Point, Florida. This program has been reasonably successful in providing improved varieties for Louisiana conditions. A new program of sugar cane improvement is just starting under the auspices of the Louisiana State University.

In general, the sugar cane breeding programs visited were less extensive than that in Hawaii. The breeders envied the Hawaiian program in its ability to make a large number of crosses and to test a large number of seedlings, but they apparently fail to appreciate that these features are only possible as a result of intensive reduction of per-cross and per-seedling costs. The need for streamlining techniques has not made itself strongly felt in areas where labor is cheap. Crosses are still made laboriously and seedlings handled expensively. There seems to be a great reluctance to adopt new procedures, even if by so doing the advantages of the Hawaiian program could be realized.

HSPA COOPERATES WITH USDA ON SUGAR CANE CYTOLOGY

A Memorandum of Understanding which outlines the terms of a joint USDA-HSPA project for research in sugar cane cytology has been signed by both parties. On September 1, Dr. Samuel Price was employed by the Division of Sugar Plant Investigations, USDA, and assigned to the project as cytogeneticist. Prior to transferring to the Division's headquarters at Beltsville, Dr. Price will devote four months to a survey of the Hawaiian breeding collection.

These cytogenetic investigations will include a study of the number and behavior of chromosomes in the various species, both cultivated and wild, and in their hybrid offspring. The purpose of this research project is to develop information that will lead to a better understanding of the chromosomal basis of heredity in sugar cane.

CONTROLLING THE FLOWERING OF SUGAR CANE

Chemical Sprays Inhibit Tasseling

Inhibition of flowering was accomplished with several chemicals applied in a single spray application. The most promising new chemicals were Shell Oil Company #1692 (alpha-Naphthylmaleinimide) and Pennsylvania Salt Mfg. Co. NP-814W70 (pentachlorobenzoic acid). Study on both will continue this year under more varied conditions.

Maleic hydrazide was again the most uniformly

Figure 32. Maleic hydrazide suppressed flowering in these test plots.

Figure 33. Flowering was reduced by withdrawing irrigation water in August and September.

successful chemical for flower control. In a total of 10 plots, this chemical was applied on August 15 and August 25 at two levels of concentration, 3 per cent and one per cent.

Time of application had no measurable effect on the results. The physiological responses are of sufficient duration to allow considerable leeway in date of application.

That the one per cent concentration did not give quite as perfect control was shown by the fact that there were only 84 per cent non-tasseled stalks as against 94 per cent at the 3 per cent concentration. The tassels were mostly unemerged.

In the aerial view of the maleic hydrazide test put in by Lihue last fall, the sprayed plots show relatively few flowers (Figure 32). Recent harvest results show a gain of about 1.5 tons of sugar due to the use of maleic hydrazide. Many new tests are being installed this fall. New chemicals are being tested on many small plots at the Makiki Station this fall.

Inhibiting Tasseling by Withdrawing Water

By withdrawing irrigation water from August 15 to October 2, 1952, at Makiki, the emergence of practically all flowers was prevented. However, some of the plots, when harvested on March 6, 1953, had large numbers of false tassels (unemerged flowers) and some tassels just coming through. At this same time, in one of the six plots at Makiki, 47 per cent of the stalks had unemerged tassels.

It is, therefore, evident that a casual inspection of a treated field may give a false impression of the results.

Figure 33 is an aerial photograph of a controlled irrigation experiment at Lihue. The harvest data show no gain in sugar, but other interesting effects are worth further investigation.

Attempts to Induce Flowers Fail

Production of flowers in non-flowering varieties continues to be an important part of the breeding program. In the fall of 1951, potted plants were subjected to days shortened by half-hour intervals, from 0 to 2½ hours (See Annual Report, 1952, p. 49). As this failed to produce flowers, the intervals were greatly increased in the fall of 1952. The day lengths were normal (about 12½ hours in September), 9 hours, 6 hours and 3 hours. Like the earlier study,

these treatments failed to induce flowering and they inhibited flowering in variety 37-1933 which was used as a control.

Among the chemical sprays used were alpha-Naphthylmaleinimide and 2, 4-dichlorophenoxy-isobutyric acid, both of which are described as anti-auxins. Both failed to induce changes which resulted in flower production in the experimental varieties.

Experiments are continuing with other changes in day length, infrared light and new chemical sprays and injection. Stimulation with gamma rays and injected radioactive salts is a further treatment which has shown some promise with other plants. The results will not be known for several months.

NEW GREENHOUSE REDUCES LOSSES IN FUZZ VIABILITY

The parent varieties in the breeding collection are far from uniform in respect to the viability of their fuzz. Some varieties produce well-developed seed which under low-temperature storage retains its viability quite well for several years. The fuzz of certain other varieties, including some of the more valuable parents, is barely able to germinate even when planted promptly after ripening. Such fuzz loses its viability rapidly when it is stored even for short periods prior to planting.

A new greenhouse, 83 feet long and 40 feet wide, was purchased last year. It was erected just prior to the beginning of the fuzz-planting campaign. This additional greenhouse space is proving valuable in facilitating the prompt planting of the fuzz of weak-germinating varieties.

THE VARIETY PICTURE — 1953

The following summary is based upon 30x30 tests harvested at the regional variety stations, and upon 30x30 and final tests harvested by the plantations. The major climatic zones will be considered in their geographical order beginning with Windward Kauai.

Windward Kauai—Makai Irrigated

In spite of its heavy tasseling, 37-1933 continues to set a high standard in the sunny makâi irrigated lands of Lihue and Grove Farm. A non-tasseling variety is needed for this area, but none of the seedlings thus far tested has shown consistent superiority over 37-1933.

In the lower irrigated lands of Kilauea, where the soil and climatic conditions approximate those of the middle rather than the makai lands of Lihue and Grove Farm, 37-1933 has been bested both by 39-3633 and by 44-3098.

Candidates for further testing: 45-2120, 46-460 and 47-2060.

Windward Kauai—Middle Belt—Irrigated

37-1933 is sensitive to the increasing cloudiness and poorer soils which, on Windward Kauai, accompany increasing elevation. On leaving the sunny coastal lands and proceeding mauka, the competitive position of 37-1933 gradually weakens. In tests situated in the middle and upper irrigated lands of Lihue and Grove Farm, 37-1933 has only occasionally been able to hold its own with 39-3633 and 44-3098. The record of 44-3098 in these tests has been somewhat more consistent than that of 39-3633. However, at Lihue, field-scale plantings of 44-3098 harvested during the past season have frequently been disappointing, while 37-1933 has surpassed expectations. The reason for this discrepancy between experimental results and field-scale performance is not yet clear.

39-7028 is proving a strong competitor in the less fertile irrigated lands. This variety may be expected to perform to best advantage under a full two-year crop in situations where it can be thoroughly ripened.

In the Lihue region, 37-1933 has probably benefitted from the warm sunny weather of the past two years. Whether this sun-loving variety can continue to maintain its good performance under the more nearly normal cloudiness of this region remains to be seen.

Candidates for further testing: 45-1361, 45-2120, 45-2708, 46-460 and 46-1463.

Windward Kauai—Mauka Unirrigated

In spite of its slow starting in plant and ratoons, 39-7028 has succeeded in establishing itself as the standard variety for the poor soils of the mauka unirrigated lands. Its excellent drought resistance has stood it in good stead during the dry weather of the past two summers. 38-2915, 39-3633 and 44-3098 have only rarely been able to equal 39-7028 under these rigorous conditions.

The mauka unirrigated lands are in need of a variety which will equal 39-7028 in yield and which will close in more rapidly and ratoon more vigorously. 39-4753, one of the few seedlings which has yielded on a par with 39-7028 in preliminary trials, is also somewhat slow in its early stages.

Leeward Irrigated—Mauka (Mauka lands of Leeward Kauai, Oahu and Maui)

In the sunny leeward districts, the yielding ability of 37-1933 is but little affected by increasing elevation so long as soil conditions remain good and irrigation is adequate. In the poorer soils of the mauka lands, and particularly in those lands which suffer periodically from deficient irrigation, 38-2915 is preferred. 44-3098 is also a strong competitor in the mauka irrigated lands, but its performance in field-scale plantings has been somewhat less consistent than that of 38-2915.

Candidates for further trial: 47-2060 and 47-2800

Leeward Irrigated—Makai (Makai lands of Leeward Kauai, Oahu and Maui)

Under these conditions, 37-1933 is usually at its best. A notable exception is found in certain areas of Central Maui where 37-1933 is affected by "Maui growth failure," and where 38-2915 is able to outyield 37-1933 by a wide margin.

By virtue of its good juices, 39-5803 has equalled or bettered 37-1933 in lowland areas which are conducive to rank growth, such as the mill-water fields of Waipahu and the newly reclaimed hydro-separator fields of Waialua.

Candidates for further trial: 47-2060, 47-2456 and 47-2800.

Hamakua and Kohala—Mauka

38-4443 has established itself as the standard variety in the poorer portions of the mauka zone. Its freedom from leaf freckle and its strong ratooning are valuable assets under these difficult conditions.

Of the many seedlings which have been tested against 38-4443 in the extreme mauka lands, only 39-5760 and 41-1045 have come through with encouraging results.

In the better portions of the mauka lands with their somewhat deeper soils and less severe wind exposure, 38-2915 has given a good account of itself. Its performance has been particularly outstanding in the upper lands of Laupahoehoe, Kaiwiki, Hamakua and Paauhau. At Honokaa, field-scale harvestings of 38-2915 have been somewhat disappointing.

Under extreme mauka conditions, 44-3098 suffers too severely from leaf freckle to qualify as a commercial variety. Toward the middle belt, however, 44-3098 begins to assert itself as a competitor in the deeper soils of the protected hollows, where its better juice quality gives it an advantage over 38-2915.

Candidates for further trial: 39-5760, 40-2069, 41-1045, 44-2772, 46-359, 46-525, 46-564, 49-612, 49-722 and 49-784.

Hamakua and Kohala—Middle Belt

Here the choice of varieties lies between 38-2915, 44-3098, 39-4753 and 41-3340. The two latter canes have done particularly well in the dry, windswept sections of this zone. In the wetter sections, 44-3098 offers the advantage of faster closing-in and somewhat higher yields.

Candidates for further testing: 44-2772, 46-525, 48-152, 48-546, 49-14 and 49-104.

Hamakua and Kohala—Makai

In the droughty sections of the makai zone, 41-3340 is establishing itself as the standard variety. An exception is to be found at Honokaa where 32-8560 continues to yield well. In areas of higher rainfall and in the irrigated lands, 44-3098 and 39-3633 are strong competitors. In the irrigated lands of Kohala, 38-2915 has also done well.

Candidates for further testing in dry unirrigated zone: 44-2772, 45-382, 45-2120, 48-152 and 48-546.

Hilo District—Mauka

38-2915 is a strong competitor in the Laupahoehoe end of this zone. Toward Hilo, rainfall increases, areas of poor drainage become more frequent, 38-2915 suffers increasingly from chlorotic streak disease and 44-3098 takes over.

Where the crop is still being cut by hand for fluming, a variety with a larger stalk than 44-3098 is needed.

Candidates for further testing: 40-2069, 44-2772, 46-359, 46-525 and 46-564.

Hilo District—Middle and Makai

Here, too, 44-3098 sets a high standard. 39-3633 has also yielded well on the better makai lands.

45-2708 appears to have possibilities as a makai variety. Its freedom from tasseling, strong second-season growth and sound condition at harvest suggest that it may compete to best advantage if carried to 24 months or older. Its good juice record recommends it for harvesting during the poor juice months at the beginning and at the end of the harvesting season. Its early recumbent nature makes it difficult to fertilize and cultivate. It is susceptible to chlorotic streak and leaf scald diseases.

45-369 has produced excellent yields in several tests, but in others it has been disappointing.

Candidates for further testing: 44-2507, 48-152, 48-160, 48-546 and 49-134.

Kau District—Mauka

Here again 44-3098 offers stiff competition. In well-drained areas, 38-2915 has occasionally equalled 44-3098.

Candidates for further testing: 41-1045, 44-2772, 46-359 and 46-564.

Kau District—Middle Belt

Under the lower rainfall and better soil aeration of the middle belt, 38-2915 has frequently equalled and sometimes outyielded 44-3098.

Candidates for further testing: 41-1045, 44-2772, 46-564, 49-5 and 49-118.

Kau District—Makai

The periodic droughts suffered by these lower lands are too severe for 38-2915 and 44-3098. Under the subnormal rainfall of the past two years, the drought resistance of 41-3340 has attracted favorable attention.

Candidates for further testing: 45-2120, 46-460 and 46-564.

In Conclusion

The regional station preliminary testing and the plantation 10x15, 30x30 and final testing supplement each other to form an integrated program. The prospect for better varieties for the future is contingent upon the effective functioning of each component of the program.

The three major varieties, 37-1933, 38-2915 and 44-3098, are setting high standards in the regions to which they are best suited. In each region, however, there are one or more contenders which have shown promise in preliminary trials at the regional stations and which are now undergoing further testing on the plantations.

39-7028 AND 44-3098 OUTSTANDING AS PARENTS

Each year, at the end of the selection season, the selected seedlings are classified according to parentage with the object of assessing the breeding value of each of the parents employed in the crossing program. An analysis of selection percentages for the past two years shows that 39-7028 and 44-3098 stand at the top of the list of superior parents.

It has been necessary to resort to special measures in utilizing these two canes as parents. 39-7028 produces only an occasional tassel in the Kailua breeding plots. 44-3098 produces tassels in fair number but the viability of its fuzz is extremely low.

Through the cooperation of the windward Kauai plantations and the Island Representative and his staff, many hundreds of tassels of 39-7028 have been collected from plantation fields and shipped by barge to the Kailua Field Laboratory for use in breeding. As a result of this joint effort, it has been possible to use 39-7028 in a wide range of crosses, both melting pot and bi-parental. In 1952, 33,000, and in 1953, 133,000 seedlings of 39-7028 were raised.

Through the cooperation of the Oahu plantations and of the Waipio Substation staff, large numbers of tassels of 44-3098 were collected from plantation fields and transported to the Kailua Field Laboratory for use in crossing. This joint effort resulted in 27,000 seedlings in 1952 and 50,000 in 1953.

The populations of 39-7028 and 44-3098 seedlings of earlier years have yielded some remarkably vigorous and attractive individuals. It appears likely that both canes will become prominent in the pedigrees of future commercial varieties.

Other Superior Parents

Special attention is to be given to a select group of canes which are well above average as parents as indicated by the percentage of selectable seedlings among their progeny. A list of priority crosses in which these canes will serve as parents is being compiled for execution during the coming crossing sea-

son. The list of elite parents includes the following: 37-7202, 39-3633, 39-5803, 40-729, 41-1181, 41-3340, 41-3620, 43-1753, 43-1884, 44-1117, 44-2364, 44-2818, 45-385, 45-2120, 46-359, 46-551, 46-1066, 46-2113, 46-2615, 46-2727, 46-2731, 47-3398 and 47-4991.

BREEDING CANES OF FOREIGN ORIGIN

During the past season, Trojan was used extensively in crosses with Hawaiian parents. Many thousands of seedlings germinated from these crosses are now growing in the field.

Other canes of foreign origin which show promise as parents are: Burma spontaneum, Co. 270, Co. 331, B 37161, B 4098 and Uba Marot.

The first of the Burma quarterbreeds produced tassels last season; these were backcrossed once more to local breeding canes.

The foreign canes released from quarantine last March include: B 37172, B 41227, B 4362, Pindar, Q 50, and other varieties of interest as parents. The breeding potentialities of these canes will be explored in crosses with local varieties as tassels become available.

1952-1953 CROSSING CAMPAIGN

Last season's crossing campaign was begun on November 21, 1952, and was concluded on January 7, 1953. Tasseling in the breeding plots was somewhat lighter than normal. However, the crossing season was again favored by the absence of destructive wind storms. The crosses are summarized in Table 1.

TABLE 1

Number of Crosses Completed During 1952-53 Crossing Season

General melting pot crosses	1,640
Leeward melting pot crosses	476
Windward makai melting pot crosses	209
Windward mauka melting pot crosses	274
39-7028 sib melting pot crosses	111
Bi-parental crosses	744
Selfs	5
Field crosses	162
Field crosses involving new introductions in quarantine at the Mapulehu, Molokai, Station	98
Stool crosses	7
Total	3,726

PRELIMINARY TESTING AT THE REGIONAL STATIONS

The preliminary testing activities of the regional variety stations are summarized in Table 2.

Omitted from the tabulations are the following:

1. Breeding and spreading areas at the Kailua Field Laboratory.

2. "Super" selections—1801 5x3 plots.

3. Field Nurseries under special conditions on plantations:

Olaa	201	flats
Paauhau	50	"
Kohala Sugar	205	"
Hutchinson	50	"
Hawaiian Ag.	106	"
	612	

4. 5x3 plots under special conditions on plantations.

Kekaha	787
Kilauea	448
H C & S	1316
Kohala Sugar	425
Hutchinson	425
Hawaiian Ag	1075
	4476

5. 5x6 plots under special conditions on plantations.

Kekaha	115
Hawaiian Ag.	107
	222

TABLE 2

Plantings made in 1953 at Regional Stations

Regional Stations	No. of Flats (No. of Seedlings per Flat 100 to 1000)	5 x 3 No. of Sdlg. Plots	5 x 6 No. of Sdlg. Plots	10 x 15 No. of Sdlg. Plots	30 x 30 No. of Sdlg. Plots
Kailua Field Laboratory	3,534	2,645	.....	.....	.....
Waipio Substation	1,913	3,632	1,644	265	60
Waimano Mauka Variety Station	1,321	3,310	1,381	157	40
Ewa Variety Station	215	2,077	688	84	18
Helemano Variety Station	.....	3,173	879	75	.....
Helemano Makai Variety Station	.....	.....	.....	.....	23
Hilo Variety Station	290	3,335	2,016	87	21
Hamakua Makai Variety Station	255	2,482	1,499	120	26
Hamakua Mauka Variety Station	105	2,509	1,513	84	20
Kohala Variety Station	.....	1,453	1,203	69	24
Kau Variety Station	198	2,213	2,344	78	21
Maui Variety Station*	.....	2,489	.....	.....	.....
Kauai Variety Station	242	2,774	1,367	145	36
Total	8,073	32,092	14,534	1,164	289

* *Discontinued in 1953.*

VARIETY TESTING ON THE PLANTATIONS

It is the function of the regional station testing program to select, from among the million or more seedlings germinated each year, several hundred that show promise of commercial value in one or another of the various climatic regions of the plantations.

It is the function of the plantation testing program (10x15, 30x30 and final testing) to determine which, if any, of these several hundred seedlings are superior to the present standard varieties.

Any impairment of the plantation testing program must tend to jeopardize the returns from the investment in breeding. During recent years, the program has operated under increasing difficulty for two reasons.

(1) The cost of harvesting trial plots by hand has risen drastically. Because of the amount of uprooting involved, rake or grab harvesting of trial plots is out of the question. The problem of harvesting variety tests and other field trials will be eased only with the further development and adoption of suitable mechanical cutters.

(2) It is difficult, if not impossible, to obtain reliable crusher-juice samples from trial plots in those mills which have failed to provide a means of bypassing the cleaning plant. The Sugar Technology Department is at present exploring a new approach to the problem. Their method utilizes a silage cutter to facilitate the subsampling of a large sample of cane, followed by comminution of this subsample in water to extract and determine its sucrose content.

The conventional crusher-juice sample permits the determination of per cent sucrose *in juice* but it provides no information as to differences in the ratio of juice to fiber in cane of different varieties and from different treatments. If it can be perfected, the new method will provide for the first time a practicable means of determining per cent sucrose *in cane.*

On a majority of the plantations, the variety testing program has been well maintained in spite of the prevailing difficulties. Table 3 shows the number of 10x15 and 30x30 tests installed year-by-year during the past five years. Table 4 lists the varieties which have been included in final tests during the past year.

TABLE 3

Number of Preliminary Tests Installed by Plantations (For Fiscal Year Ending June 30)

Type of Test	1948-49	1949-50	1950-51	1951-52	1952-53
10 x 15	54	62	70	92	70
30 x 30	41	47	50	71	73

TABLE 4

Replicated Variety Tests Installed by Plantations
July 1, 1952 to June 30, 1953

Variety	Kauai	Oahu	Maui	Hawaii	No. of Entries Total
Trojan	....	....	1	....	1
32-1063	....	....	....	1	1
8560	2	....	....	4	6
37-1933	4	6	3	....	13
38-2915	1	3	2	15	21
4443	....	....	....	4	4
39-723	....	....	....	2	2
3633	....	....	....	4	4
4753	1	....	....	3	4
5803	....	2	....	....	2
7028	2	1	....	2	5
41-3340	....	....	....	5	5
44-2772	....	....	....	10	10
3098	1	3	....	23	27
45-369	....	....	....	3	3
2120	1	....	....	....	1
2708	....	1	1	6	8
46-359	....	....	....	7	7
460	....	1	....	....	1
551	....	....	....	2	2
564	....	....	....	5	5
2404	....	2	1	....	3
47-2060	....	2	....	....	2
4991	....	1	....	1	2
48-152	....	....	....	3	3
3166	....	2	....	2	4
49-134	....	....	....	4	4
Totals for					
1952-1953	12	24	8	106	150
1951-1952	42	23	3	107	175
1950-1951	32	7	0	108	147

DISTRIBUTION OF SEED

In addition to their testing functions, the regional variety stations serve as sources of seed for preliminary testing on the plantations. Details as to seed distribution during the past fiscal year are shown in Table 5. It will be noted that nearly half of the total amount of seed supplied for preliminary testing came from Waipio Substation, which serves as a central seed source for all Islands.

TABLE 5

Seed Shipments to Plantations—July 1, 1952 to June 30, 1953

Source	For Seed Nurseries in Preparation for Replicated Tests—Tons	For Other Seed Nurseries Tons	For 10 x 15 No. of Plots	For 30 x 30 No. of Plots
Kailua Field Laboratory	.....	.60	.....	....
Waipio Substation	.....	3.88	1,970	23
Maui Variety Station	.....	2.03	232	6
Hilo Variety Station	.50	3.15	251	1
Hamakua Makai Variety Station	.....	1.93	919	9
Hamakua Mauka Variety Station	.....	.63	138	2
Kohala Variety Station	.....	.28	131	2
Kau Variety Station	.....	1.38	186	1
Kauai Variety Station	.....	.....	60	6
Totals	.50	13.88	3,887	50

ACREAGE CENSUS OF CANE VARIETIES

The area planted during 1952 totalled 35,078 acres. This marked decline from the all-time high of 1951, when 43,893 acres were planted, is an encouraging sign; it reflects improvements in harvesting procedures which are resulting in a reduction of damage to the stubble, thus permitting a higher proportion of ratooning.

44-3098 heads the list of varieties planted during 1952 with 13,543 acres, localized for the most part on windward Kauai and on Hawaii. In second place is 37-1933 with 8908 acres. The acreage of this variety is confined entirely to the irrigated lands. In third place is 38-2915 with 6723 acres, widely distributed over Central Maui, and over the poorer middle and mauka lands of the other Islands.

As to total area in plant and ratoons, 37-1933 remains the leader with 69,586 acres. 44-3098 with 40,580 acres has risen to second place. 32-8560, which at its peak in 1946 occupied 133,000 acres, has dropped to third place with only 32,040 acres remaining. In fourth place is 38-2915 with 31,755 acres. 32-1063, which for many years stood second only to 32-8560, and which reached its peak in 1949 with 36,693 acres, has now dropped to fifth place with 20,213 acres. This decline reflects the plowing out of 32-1063 ratoons and their replacement with 44-3098.

The total area in cane at the end of 1952 was 219,155 acres indicating a gain during the year of 1085 acres.

WATER DEVELOPMENT

AREAL AND STRUCTURAL GEOLOGY

Kilauea Geology Studied as Background for Ground-Water Development

Most of the basic studies of geology had to be deferred during the year because of critical hydrologic problems arising from drought and low ground-water storage levels. The major geologic work was the completion of a detailed survey of part of Kilauea Sugar Plantation Company on Kauai and the watershed area contiguous to it (Figure 34). Dikes retaining water at high levels in the Kekoiki Ridge, the highest ridge back of the plantation, have been mapped, and estimates of possible yield and storage of a dike tunnel are being based on the flow of springs and spring-fed streams draining the ridge. The Kamokoa Ridge, a low spur extending south of the Kekoiki Ridge, is composed, like the main ridge, of the earlier series of more pervious lava flows of Kauai and is surrounded by flows of the later, less pervious series. The possibility has been suggested that this ridge contains high head basal water. The probable costs of developing water from either area must be balanced against the costs of the further development of surface water from Kalihiwai Stream that may also be a possibility.

Other Geologic Studies

Another geologic study of a dike area was made in Honokohau Valley on Maui, from which water is taken by Baldwin Packers for delivery to Pioneer Mill Company. In this valley, the trend of the dikes is predominantly parallel with the stream, so that by tunnelling at right angles to the valley, there is some likelihood of developing water that is not now draining to the stream. Two existing tunnels are not encouraging examples, but their lack of success is due partly to their location in a vent complex and partly to a poor layout.

The geology of the Kealia-Anahola area of Kauai was reviewed in the field to permit recommendation of suitable test hole sites to explore possibilities of basal ground-water development for irrigation supplies in that area.

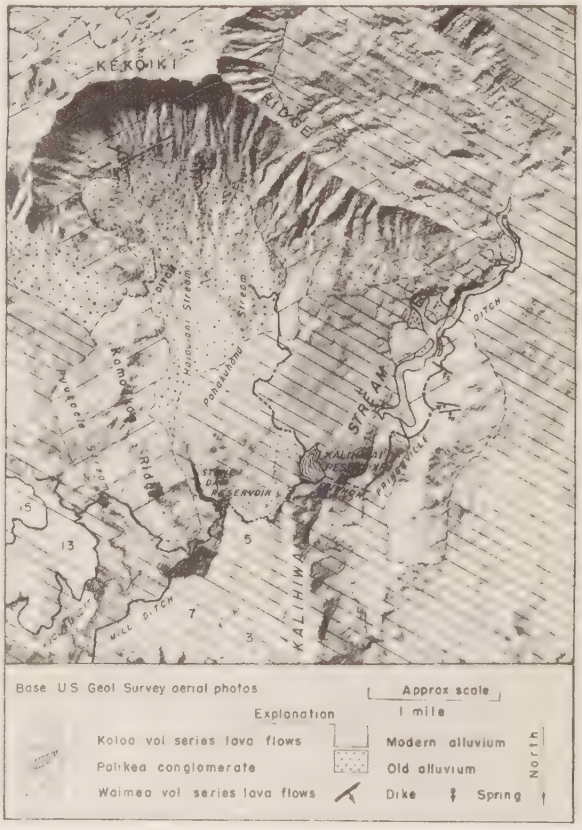


Figure 34. Geologic map of the western part of Kilauea plantation and tributary area shows dike springs and the present water development system.

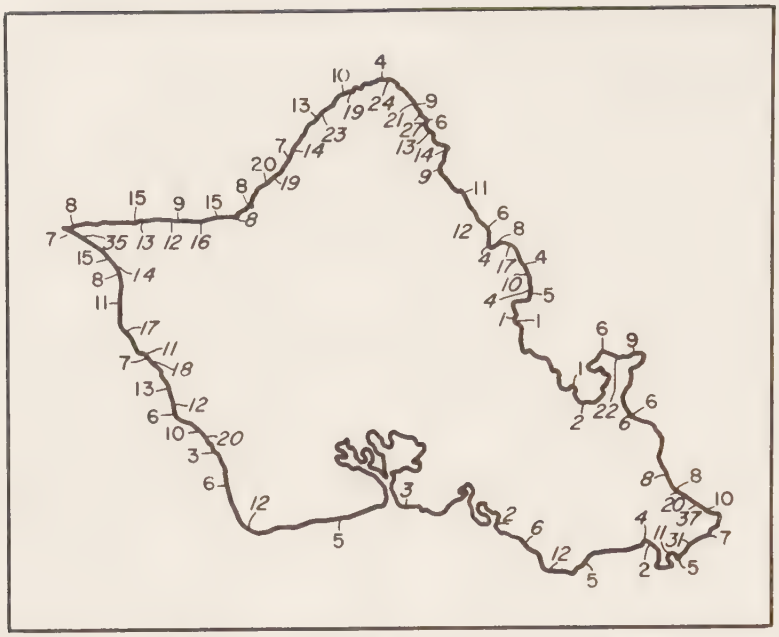


Figure 35. Map showing heights to which the 1946 and 1952 tsunamis washed on Oahu shores. The slant numerals inside the coastline indicate the 1946 heights, while the erect numerals on the outside indicate the 1952 heights.

DYNAMIC GEOLOGY

The 1952 Tsunami

A study of the intensity and effects of the tsunami (tidal wave) of November 4, 1952, was made on Oahu in cooperation with the Geological Survey. This study was similar to the one made on all the islands in 1946. The same controls were found effective. Differences between the 1952 and 1946 effects resulted, first, from the different angle of incidence of the waves, originating in 1952 off Kamchatka and travelling along the Hawaiian chain, rather than coming across continuously deep water from the Aleutians as in 1946; second, from the generally longer period, at least as observed in Hawaii; and third, from a lower initial height of the waves. The range of heights to which the two tsunamis washed on Oahu is shown in Figure 35.

EXTENDED RAINFALL NEEDED TO RECHARGE GROUND-WATER BODIES

That 1953 has been a dry year is widely recognized. In unirrigated cane areas where even the deficient rainfall was sufficient, and in irrigated cane areas whose water supplies have proved adequate, the dryness and associated high temperatures and sunlight have been beneficial. However, in unirrigated areas with borderline rainfall, some of the cane, especially in the new crop, has suffered, and in some irrigated areas, deficiencies and difficulties in water supplies have shown up with similar results.

The major, obvious deficiency in rainfall may be ended by a good month's, or a few good months', rainfall; but some of the deficiencies in irrigation water supplies are the result of a long accumulation of very minor annual deficiencies in rainfall and will be ended only by similar long continued excesses in rainfall. In casual inspection of rainfall records, long-term trends are masked by the much larger short-term variation. However, these long-term trends are very important in producing changes in ground-water bodies. They are of major importance in ground-water bodies with storage volumes that are large in comparison with the rates of flow through them, such as most dike-retained and basal, Ghyben-Herzberg

bodies. The effects of day-to-day variations in rainfall are lost, and even those of month-to-month variation are very greatly damped by their cumulation over long periods of time.

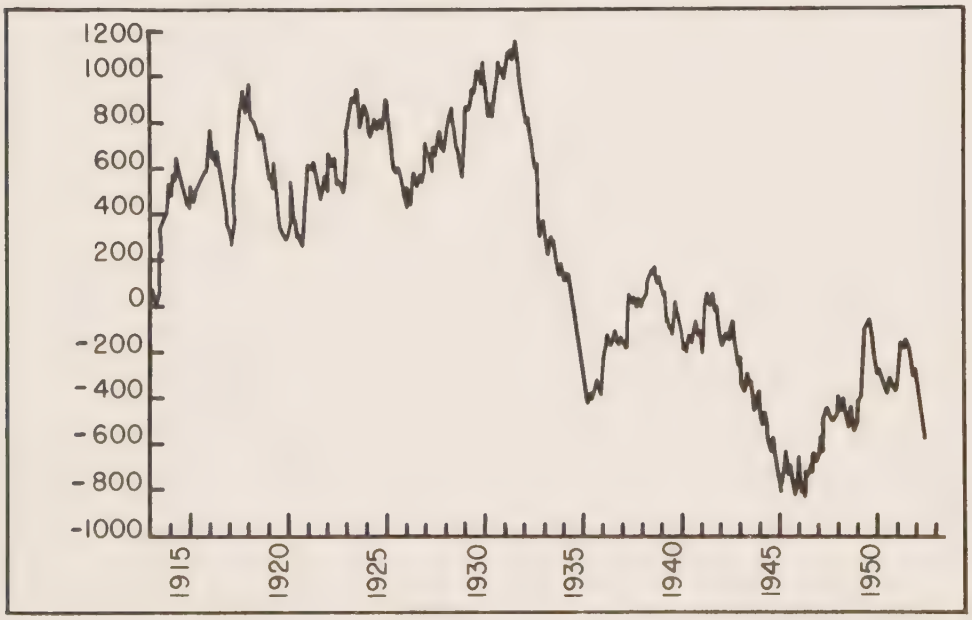
As an example, there is plotted, in Figure 36, a cumulative rainfall index that has been found to have a good correlation with ground-water levels in the basal ground-water body at Wailuku, Maui. It will be seen that the late 1953 cumulated effect of rainfall on the recharge area of this body is at a level much lower than the average for the period of record; only the levels in 1945-1947 are lower.

As a result of the long-term deficiencies in recharge, ground-water levels are generally low throughout the Islands. The consequent deficiency in spring and high-level basal flows is added to the deficiency in surface flows resulting from the current deficiency in rainfall, making total stream flows that are less than normal, and are in many areas at extraordinarily low levels.

Short of both rainfall and stream-fed ditch flow, the plantations having basal ground-water wells have drawn on them more heavily than usual to make up the deficiencies. But even in the basal ground-water bodies, difficulties have been encountered, resulting from either the long-term deficiency in recharge or the current high rate of draft, or both. Some of these difficulties have been short-lived and comparatively trivial; others are of major importance to the plantations concerned.

Practically the entire work of the Geology Department for the year has been devoted to attempts to solve these difficulties, and to studies of location for possible new ground-water development for plantations that have, in these dry times, found their water supply deficient or that have decided to attempt to remedy a deficiency already recognized. Very little time has been available for long-range studies; several already far advanced have had to remain dormant. The existence of the difficulties and inadequacies in present ground-water supplies is, of course, partly the result of conscious acceptance of the risks and temporary deficiencies inherent in the development of water supplies. It is also partly the result of not knowing the expectable ranges of variation in ground-water quantities and qualities. Insofar as the difficulties and inadequacies are the result of such ignorance, they are examples of the economic value of extending ground-water knowledge.

Figure 36. The recharge index for the Wailuku ground-water area is shown. The index is obtained by cumulation of rainfall records.



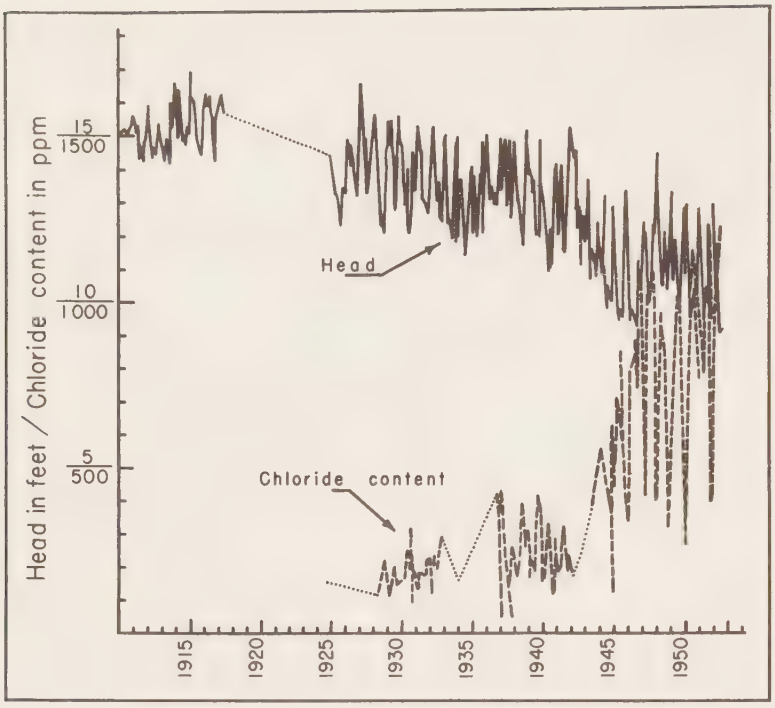


Figure 37. Diagram shows the lowering head in Kahuku ground-water area and the rising salinity at Kahuku Pump 5.

SALT INCREASES AT KAHUKU PUMP 5

The most serious difficulty was experienced at Kahuku Pump 5, on Oahu. This pump, the largest at Kahuku, draws on 11 very deep wells. For several years, the salinity at Pump 5 has had a tendency to increase. A year ago the two most saline wells were blanked off, but the salinity of the station kept increasing until this summer, when the chloride content topped 1200 parts per million, and the draft had to be drastically reduced. The long-term loss of head in the Kahuku ground-water area (Figure 37), resulting from a long-term trend of decreasing rainfall and increasing draft, must have induced a rise in the zone of mixture at the bottom of the fresh-water lens, that has been the principal reason for the increase in salinity at Pump 5.

The salinity record is complicated by an increased sensitivity with draft at higher salinity levels, and perhaps by lags in rises in the saline zone behind drops in the water level. It is believed that Pump 5 cannot now be relied on for more than a small portion of its past draft, and alternate water sources are now under study.

MANY PLANTATION WELLS SHOW DIFFICULTIES

As examples of temporary and comparatively minor difficulties, daily inadequacies of yield at the Ookala Well on Hawaii and at Waialua Pump 4 on Oahu may be cited. Once a day this summer, the mill pump at Ookala had to be shut down completely to permit recovery in the well, and once a day the draft at Pump 4 had to be reduced to prevent loss of suction. In both cases the difficulties were caused by the superposition of tidal lows on a low mean water level. Ookala's trouble was limited to a brief period in time when the tidal range was at a maximum, and it cleared up when the tidal range decreased. Waialua's trouble came in July when, presumably, heavy draft had reduced the water level enough so that the low tide level in the well was lower than earlier in the year when the tidal range was greater. Waialua's trouble was cleared up by tapping into the Pump 4 system a pond containing a sizable spring.

The resulting change in low tide drawdown is shown in Figure 38.

Other difficulties induced in part by the low water levels in basal ground-water bodies were encountered at the Honokowai Well, Pump R, of Pioneer Mill on Maui, and at the Kohala Well on Hawaii. Methods of improving yields at these low water levels were suggested and limitations were outlined.

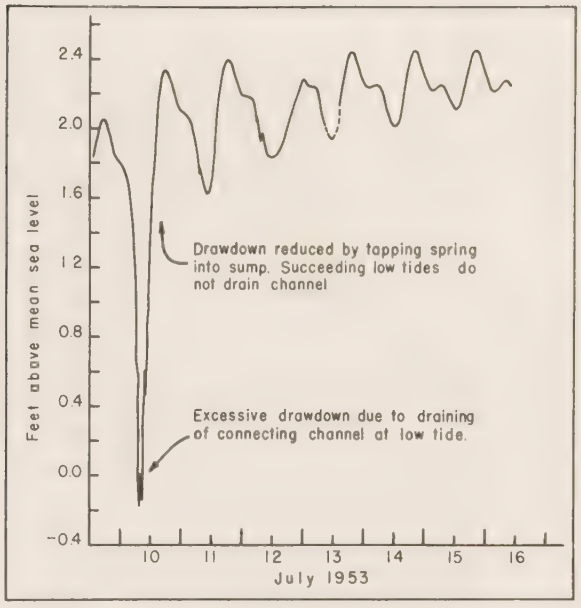


Figure 38. Drawdown levels at Waialua Pump 4 during part of July, 1953.

MIXING-ZONE TESTING NEEDED TO COMPUTE STORAGE CHANGES

A stumbling block in the computation of storage changes has long been the uncertainty as to how greatly changes in the level of the zone of mixture at the bottom of basal fresh water lenses of the type common in Hawaii lag behind the changes in water level that induce them. To start investigation of this lag, a mixing-zone test well is highly desirable in some area where the geology and the geometry of the lens are relatively simple and where the water level and ground surface are low, so that the zone of mixture lies at moderate depth. The construction of such a well has been recommended to H C & S because parts of the Maui Isthmus ground-water body meet these requirements, and because present recording of water levels in this body is fairly good and is to be further improved.

NEW WELLS FOR MORE WATER

Two new wells at sites recommended by the Geology Department have been completed and tested during the year.

A Maui-type well with a capacity of 12 million gallons per day, consisting of a 65-foot shaft and a 215-foot tunnel, was dug at Puunene to supply cooling water for an enlargement of the Puunene power plant. The water will be used for irrigation after it passes through the plant. The tunnel of the new well is shown in Figure 39.

Two 600-foot drilled wells were completed for the Maui County Waterworks in the Mokukao section of Iaò Valley. Tests of these wells indicate that, so far as the well hydraulics are concerned, they can each supply three million gallons per day, and pumps of that capacity have been ordered. Because of uncertainties as to the ultimate safe yield of the Wailuku aquifer from which these wells draw, a comprehensive program of careful water-level measurement and recordings has been recommended.

Construction of one major new well has been started during the year by Waialua in Opaeula Gulch on Oahu. The well is to be of the Maui-type, with a shaft about 250 feet deep, and a tunnel expected to be around 1000 feet long. The capacity desired is 14 million gallons per day.

Several other potential developments, or increases in present development, in connection with geologic and hydrologic work, have been studied. A test well was drilled by Grove Farm Company near the Koloa Mill on Kauai and tested by recharge, indicating a permeability limitation that requires further exploration. Possibilities of developing water from the Ukoa swamp or nearby parts of the Kawailoa bedrock aquifer near Waialua Pump 4 on Oahu were investigated, and recommendations of limits necessary to protect Pump 4 were made. For dry weather mill supply, possible further development of perched springs at Papaaloa used by Laupahoehoe was investigated with negative results, and not recommended.

Figure 39. Inflow to the tunnel of the new Maui-type well at the Puunene power plant.

TITANIUM INTEREST REQUIRES CAUTION

A review of titanium research pertinent to Hawaiian high-titanium soils was made early in the year that turned out to be valuable in an evaluation of possibilities of a Hawaiian titanium industry when these possibilities were highly publicized. Methods and economics of concentration of the titanium minerals from the soils are the principal uncertainties. Research on concentration methods and on the mineralogy and nature of the deposits is to be encouraged, but for the time being, only by agencies whose interest is in the general phase and by support on the broadest base possible.

No Hawaiian soil can yet be regarded as a titanium ore.

DAM SITES FOR IRRIGATION WATER

An inspection of a dam in Kaupakalua Valley, Maui, which was to be made higher, revealed that part of the foundation was a pervious and leaky gravel bed. The leaks were stopped by the construction and backfilling of a cutoff trench on the upstream side of the dam, but raising of the dam was not recommended to East Maui Irrigation Company, owner of the dam. A program of foundation exploration was recommended for alternate sites further up the valley.

Recommendations were made for grouting to form a cutoff well in jointed, weathered rock under McBryde Sugar Company's reservoir 19 dam at Lawai, Kauai. The grouting resulted in sealing off inflow to the core trench, and so will probably be highly effective in reducing underflow.

Deep excavation and grouting are being carried on in the construction of a new intake dam at Wainiha, Kauai, to reduce underflow previously found in valley gravel.

WEATHER

HAWAII'S 1953 DROUGHT ONE OF THE MOST SERIOUS IN HISTORY

During the past year, areas of unirrigated sugar cane have felt the effects of one of the most prolonged periods of low rainfall in the rainfall records of Hawaii, some of which go back 75 years. To offset this, however, some irrigated cane areas have had temperature conditions much more favorable to growth than normal. With adequate irrigation water, this has meant that in these areas sugar production has been high.

Members of the Meteorology Department staff, in studying the factors which contribute to the drought conditions, have found that the tendency for drought in dry areas is generally not followed in the high rainfall watershed regions. This is illustrated by the maps in Figure 40, which summarize the rainfall conditions for the 12-month period ending September 1, and which show how far from normal the recent period has been.

The maps show that the normally rainy areas on windward Hawaii, Maui, Oahu and Kauai, have not been nearly as dry in relation to their normal rainfall as most of the areas which receive an average of 50 inches of rainfall or less. The small bar graphs beside the island rainfall maps indicate some of the temperature conditions which have occurred for the present crop. They also show that where dry weather has persisted, temperatures have been generally more favorable for cane growth.

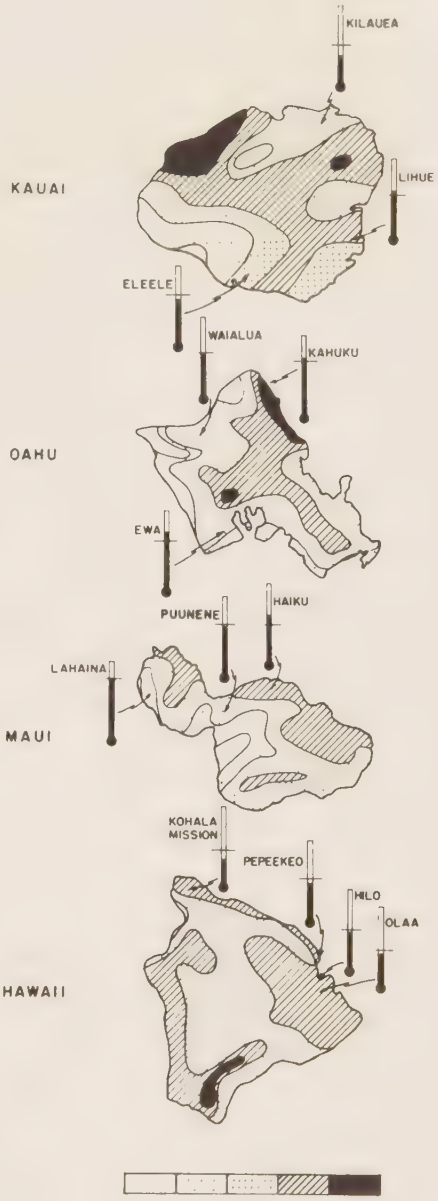


Figure 40. Rainfall and temperature conditions in the Hawaiian Islands for 12 months prior to August 31, 1953. Blacked-in areas indicate normal rainfall, or better. All other areas are deficient in rainfall, some areas having received less than 25 per cent of their normal rainfall for 12 months. The horizontal lines drawn across the thermometers indicate the normal temperatures of the areas shown. Temperatures above normal are indicated by blacking-in the thermometer above the normal line.

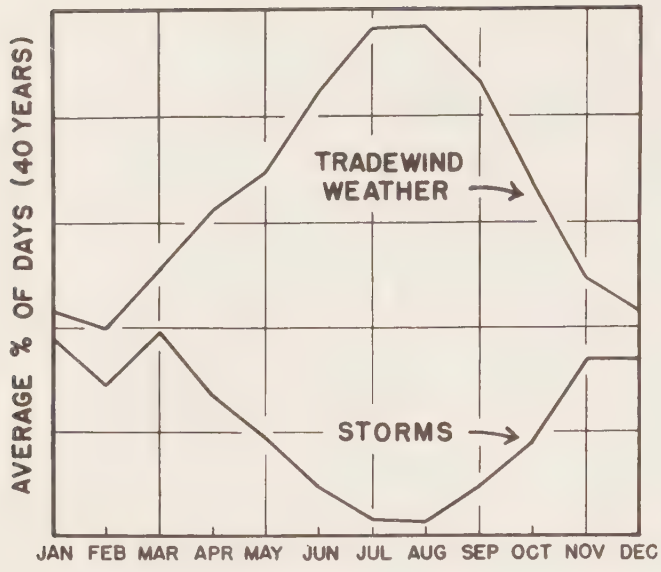


Figure 41. Seasonal variations in weather affecting rainfall in Hawaii. The average rainfall expectancy for different areas is affected by two rain-producing weather conditions which have two different seasonal trends. The graph above shows the frequency with which storms and trade wind rain showers normally occur in different seasons. This year's drought is largely a result of an almost complete lack of storm weather. For this reason, areas which receive most of their rainfall in winter and from storms, have been most severely hurt. (See Figure 40)

In Hawaii, distinctly different drought conditions can be the result of one or several causes. The occurrence of drought over wide areas may be the result of one meteorological situation, or it may be a combination of several causes which can make a drought more widespread and serious. Some droughts are a result of abnormal trade winds. This year's drought resulted because the Islands were by-passed by the general and widespread storms of the Pacific.

One of the chief business risks, so far as crop failure is concerned, lies in the weather. A detailed knowledge of the frequency, severity and cause of drought in various areas of the Islands is paramount if the weather is to be given proper consideration in the evaluation of long-term business risks.

Working toward this objective, the Meteorology Department analyzed a large body of meteorological information which yielded a number of interesting facts concerning the nature of rainfall in Hawaii. One has been that the determination of the tendency for drought conditions in certain areas of the Islands is offset by normal, or more than normal, rainfall in other areas. This is a result of two basic local causes of rainfall. Most Island residents know in a casual way that rainfall here is associated with the frequency of storms and the frequency of rain-producing, trade wind weather conditions. These two situations are, meteorologically, quite independent and influence different areas of the Islands differently (Figure 41). Storms occur only in the absence of trade winds (mostly in winter), and affect the dry areas more than they do the very wet areas. Consequently, when there are no storms, areas which receive most of their rain from trade wind conditions tend to have normal or more than their normal rainfall, while dry areas of the Islands are essentially cloudless. When the situation is reversed, both areas receive appreciable rainfall, but wetter areas are generally not so dominantly affected.

This fact, of course, provides an advantage to some of the plantations which lie in relatively dry zones but which irrigate with water taken from watersheds in the high rainfall regions. With weather conditions as they have been during the past year, with the exception of the last few months, temperature, harvest weather and the flow of irrigation water are all favorable for optimum sugar production.

The Meteorology Department, working toward a complete understanding of the statistical character of the interaction of these two meteorological situations, is hopeful of achieving its goal at a relatively early date. Then it can provide plantations in each area of the Islands with accurate statistical information about the frequency and character of weather conditions which are favorable or adverse to crops or to agricultural operations.

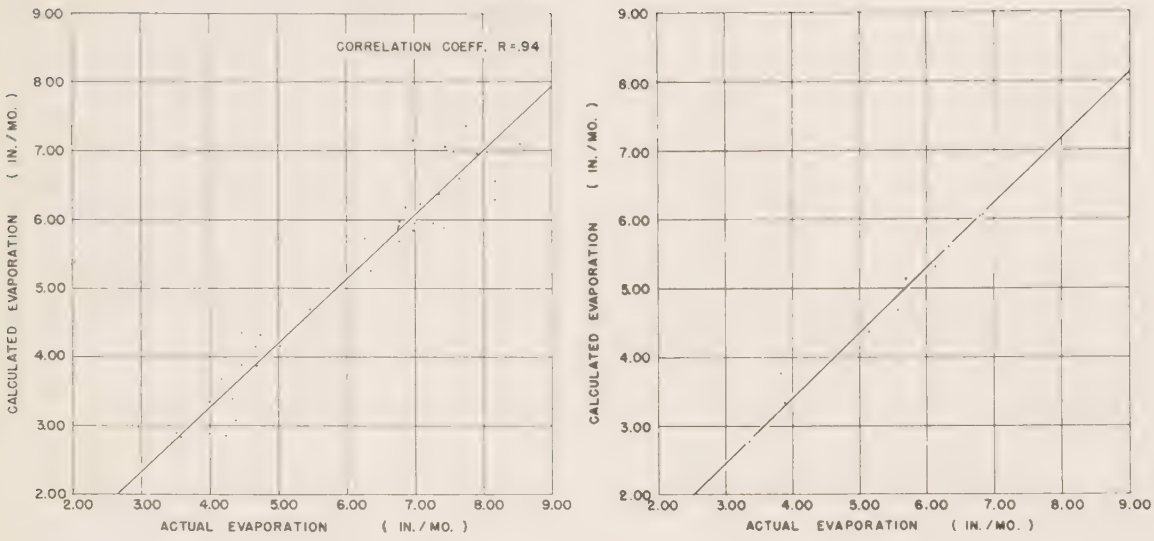


Figure 42. Calculations of evaporation from meteorological data. In the graph at the left, a comparison is shown between evaporation data obtained by calculations from measurements of sunlight, temperature and humidity, compared with the actual evaporation measured in an open pan. The sunlight measurements were taken at the Waipio substation, and the evaporation data were obtained in Waianae 10 miles away. An analysis of these data shows that the calculations are 85 per cent accurate. On the right are shown data for 1950. In this case, the sunlight and temperature data, as well as the evaporation data, were all taken at Waipio. The accuracy of these measurements is still greater.

THE EFFECTS OF METEOROLOGICAL FACTORS ON EVAPORATION AND TRANSPIRATION STUDIED

One of the knottiest problems in the production of sugar cane is the determination of the most effective and economical use of irrigation water. The consumption of water by evaporation from the soil and by transpiration from the leaves of the plant is naturally controlled by the weather conditions to which soil and plant are exposed. To determine the need for irrigation, various methods have been proposed, some of them quite satisfactory but involving such laborious procedures that in some instances they are impractical for large-scale use. Other methods, less laborious, are also less accurate. The intensive world-wide interest in this problem has stimulated scientists to new findings on the best way to account for consumption of water, and to plan its use.

In recent months, new and promising methods have been suggested which require only a knowledge of the weather factors to which the plants are exposed plus a knowledge of soil type and root depth.

In an attempt to gauge the value of this method for Hawaii, the Director of the Experiment Station and the Meteorology Department have collaborated in developing accurate calculations, based on meteorological data, of the evaporation of water from open pans. Later, it is hoped, the transpiration of water from the leaves and evaporation from the soil may also be calculated. Results to date have been encouraging.

Figure 42 shows the results of calculations of actual evaporation, compared with calculations of evaporation based on a consideration of meteorological factors alone. In this figure, 43 months of evaporation data are compared with 43 calculations of evaporation for the same station. Even though the evaporation measurements as they have been taken are subject to certain errors, and even though sunlight data were not available at the exact spot at which the evaporation measurements were made, the accuracy of these calculations is 85 per cent. Therefore, it is believed that future calculations may be almost exact.

The significance of this work lies in two considerations:

1) in the appraisal and *evaluation of the most effective use of water for irrigation* in the various localities in the Hawaiian Islands.

2) in cane ripening and in determining the irrigation interval.

If the method of calculating the consumption of moisture proves sufficiently accurate when based only on the weather conditions experienced, then some of the practical problems that have arisen in making detailed measurements of soil moisture will be resolved. An intensification of this research is therefore contemplated in the coming year.

METHODS OF MEASURING SUNLIGHT STUDIED

Sunlight measurements, which are being used in the preparation of crop log data at a number of plantations, and which have been used more recently in studying the consumption of water and its effective use in irrigation, are being studied by the Meteorology Department in an effort to determine the most satisfactory instruments for plantation use. Until recently, only two methods were available for this purpose.

The first was the use of the standard U. S. Weather Bureau pyrheliometer with an elaborate recording device, which is generally accepted by government agencies for detailed measurements of sunlight. While it does provide quite satisfactory measurements, its cost is high, making it impractical for general plantation use.

The second method, developed by the Experiment Station, HSPA, some years ago, has proved much more practical. This involves the use of tubes containing chemicals which change form when exposed to sunlight. The degree to which they change is a fairly accurate indication of the amount of sunlight to which they have been exposed. However, this method has also had certain drawbacks. The chemicals are fairly expensive and the analysis of the data is somewhat laborious and subject to human error. In addition, as the chemicals show only the total amount of sunlight received, they do not record the character of the sunlight during the day.

More recently, an instrument called an "Actinometer," manufactured by an eastern company, has been tested for its practicability for our purposes. This instrument, which is relatively inexpensive, makes a continuous recording of the intensity and duration of sunlight for a period of one week (Figure 43). Its charts not only provide a permanent record of the character of a day, but give the information necessary to determine the total amount of sunlight received over a week's period. The chart illustrated distinguishes clear from cloudy days, as well as other gradations in sunlight conditions.

A comparison of the three methods shows that satisfactory data are being obtained by the new instruments (Figure 44). More than 20 sunlight stations, using these instruments, have been established.

CLOUD PHYSICS STUDIES REACHING CLIMAX

Studies in the physics of rainfall in warm clouds, begun in November, 1951, are now reaching a climax. Their purpose is to determine the cause of warm rainfall which is found in the majority of instances in Hawaii, and the possibility of controlling it.

Following 18 months of an elaborate program in instrumentation and intensive research, detailed measurements of cloud water content and cloud droplet size, plus extremely accurate measurements of cloud temperature not possible before, are painting a picture of how warm rainfall forms.

Thus far, the scientific results of the cloud seeding tests have been quite successful. As reported last year, it has been learned that droplets of raindrop size can be produced by cloud seeding, using relatively small amounts of seeding material. The results of these tests have been determined by radar observations, as shown in Figure 45, in which clear-cut evidence exists that some rain can be produced by seeding in this new way. The amounts of rainfall, and therefore the practicality of seeding clouds by this method, have not yet been satisfactorily evaluated. It is hoped that the more detailed measurements now under way will furnish the information necessary.

Various methods of cloud seeding have been suggested, most of them involving the use of aircraft. However, some of Hawaii's unique topographic features in which large amounts of water are available

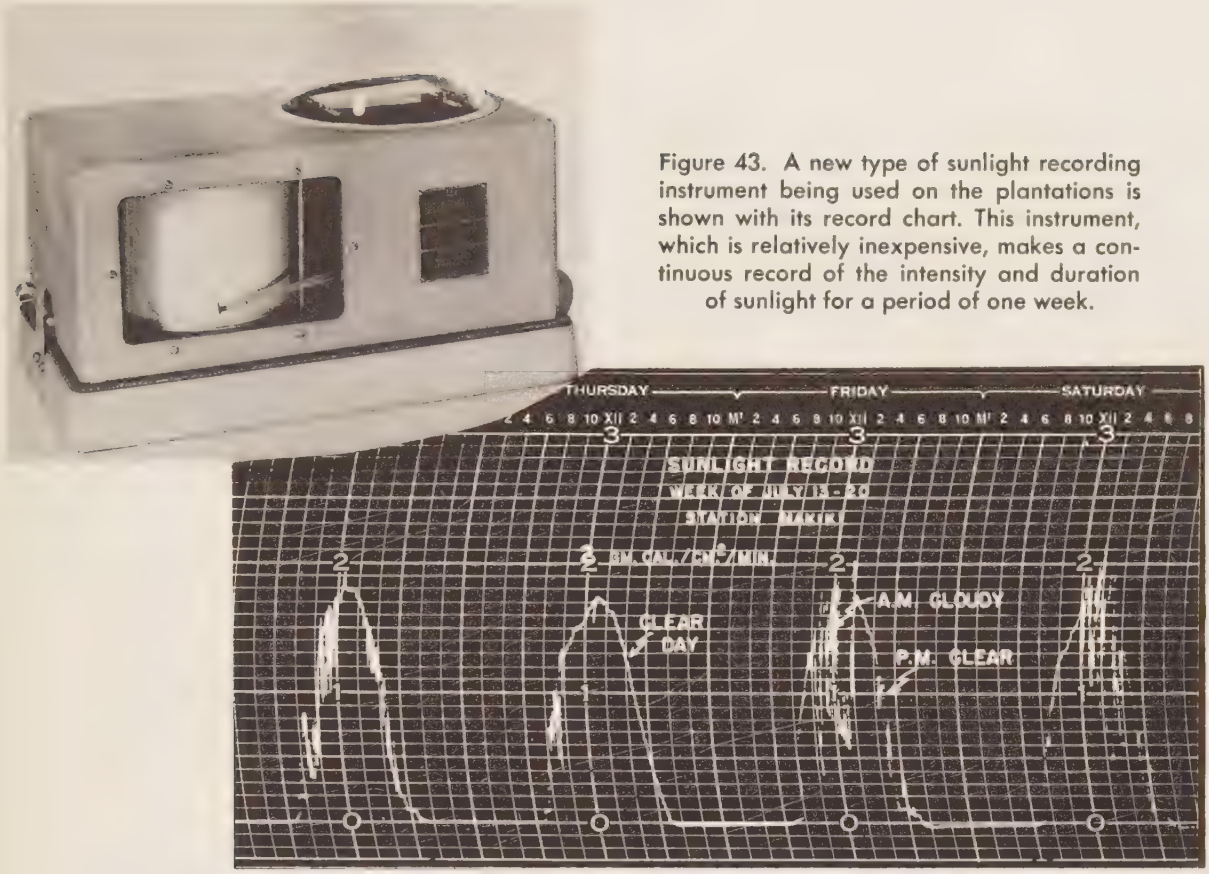
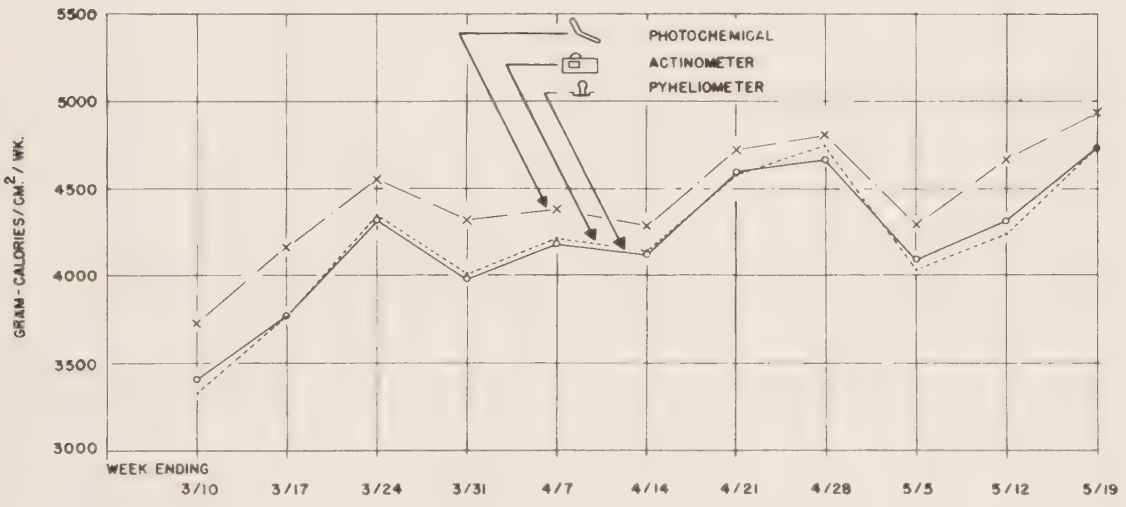


Figure 43. A new type of sunlight recording instrument being used on the plantations is shown with its record chart. This instrument, which is relatively inexpensive, makes a continuous record of the intensity and duration of sunlight for a period of one week.

Figure 44. A comparison of three methods of measuring sunlight used in Hawaii. The solid line shows the pyrheliometer which has been used by government agencies as the standard for calibration of other types of instruments. The two dotted lines show a comparison of the photochemical method and the actinometer as tested recently by the Meteorology Department.



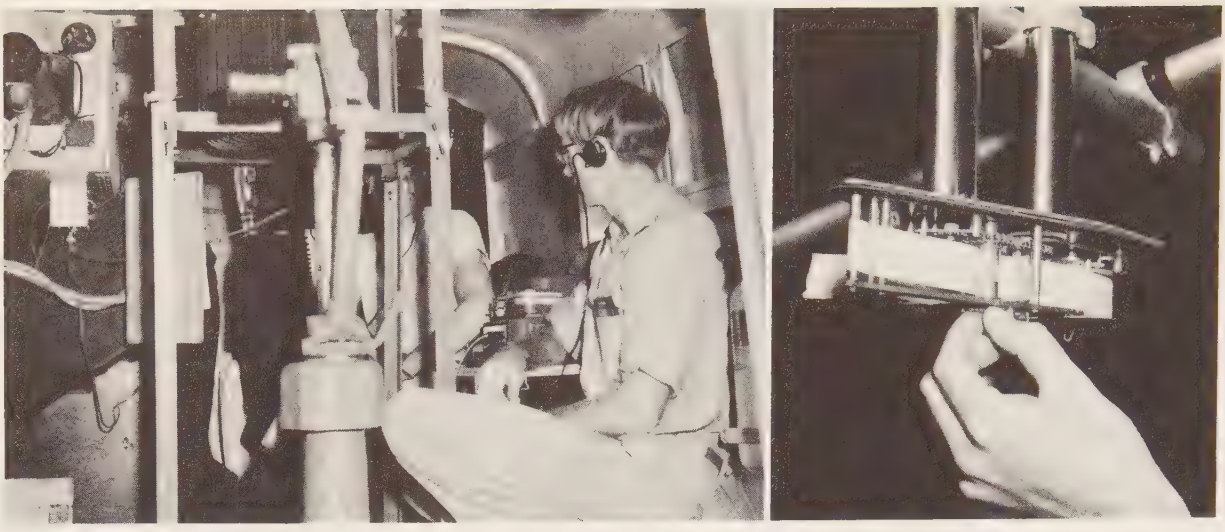


Figure 45. Apparatus which is being used in the current intensive research program on the physics of rainfall in Hawaii and artificial rainfall inducement. At the left, the interior of the radar truck is shown. At the right are the aircraft instrument installations for measuring liquid water content of clouds.

on the windward side of the mountains where air currents are rising, suggest the feasibility of seeding from the ground surface with sprays of water of the proper droplet size. The Meteorology Department has devoted considerable time and interest to this phase of the cloud seeding problem, which may offer Hawaii an even more practical outlook than other areas.

Because of the size and youth of the cloud physics field, the Meteorology Department has actually pioneered in this work. Its progress has already received world-wide attention and is being watched at home with keen interest.

COOPERATIVE LONG-RANGE WEATHER FORECASTING RESEARCH TO CEASE

For the past six years, the Experiment Station, HSPA, and the Pineapple Research Institute have provided financial support and technical cooperation for a U. S. Weather Bureau project on research into long-range weather forecasts. The ultimate objective of this research was to develop principles that would lead to more accurate methods for predicting rainfall a month or more in advance.

While considerable progress has been made, the practical possibilities of reliable month-ahead forecasts seem remote for plantation use. The problem involves thorough study of tremendously detailed and voluminous world-wide weather data, and the problem for Hawaii is only a small part of a problem global in extent.

A fairly high degree of accuracy, or skill, in long-range forecasts is essential if such forecasts are to be of value to sugar and pineapple industries in Hawaii. It does not appear possible that a sufficient degree of accuracy can be achieved within the next decade. Therefore, and in view of the extent and complexity of the problem, the HSPA-PRI support of this project for the present year has been reduced and will be discontinued by June of 1954. This does not mean that either Weather Bureau research in long-range forecasting or the long-range forecasts now received will cease. It does mean that efforts to apply forecasting techniques specifically to Hawaii will be postponed until more of the basic facts of the problem are better understood.

WEED CONTROL

DISPERSION OF CMU IN A SATISFACTORY LIQUID VEHICLE

As has been reported before, CADE has proved an ideal dispersing agent for the herbicide, CMU, which is insoluble in both oil and water. Other less effective means of dispersion, including water, dilute molasses, aromatic oils, etc., have been used experimentally as doubtful substitutes both at the Experiment Station and on the plantations. The manufacturers of CMU, as well as manufacturers of similar compounds, such as URAB (PDU), have also been actively interested in suitable dispersion vehicles. To five different manufacturers, this Station has furnished the details of the processing of CMU in CADE or ARCADE, and apparently the process has been accepted by all of them as satisfactory for the purpose.

No difficulties have been encountered in large-scale aircraft applications of CMUCADE dispersions. However, for use in small experimental plots, there is a need for a dispersing medium of lower viscosity which could hold the insoluble chemical in the same quantitative dispersion that standard CADE and ARCADE do. To meet this requirement, a much lighter-bodied ARCADE has been developed at the Station and is now being tested in field plots by the Agronomy Department.

NEW CHEMICAL TECHNIQUES FOR USE BY PLANTATION MIXING PLANT PERSONNEL

During the past year, the Chemistry Department has sent the plantations descriptive information and working formulas for several of the solutions used in processing CADE, and for diluting and supplementing its activator fraction for field application. These releases covered the preparation of standard stock solution of caustic soda, E50 solution, fluid activator stock (FAS), and, for making FAS, the aqueous portion of CADE (APC) and the stock solution of activator (SSA). These new techniques of processing were developed with three distinct objectives in view:

1. To use basic, raw chemicals in original package lots—just as they are received in the Territory. This eliminates the time consumed in opening and weighing chemicals from original packages, as well as the wastes and hazards incurred by allowing materials of a fugitive nature to stand in the mixing plant exposed to dust and to breakdown due to absorption of moisture from the air.

2. To process regularly employed stock solutions, using the least expensive chemical form of basic chemicals and, where necessary, converting them to the water-soluble form in the processing operation.

3. To store these stock solutions so that they are easily available, and so that insoluble matter and fibrous materials, which clog nozzles, can settle out, leaving a clear solution for rapid reprocessing into whatever concentrates are needed for the operation then current.

NEW HERBICIDE CHEMICALS APPEAR

The following new herbicide chemicals have been screened in the chemistry laboratories and tested in the greenhouse. Their effectiveness in small field plots is being studied by the Agronomy Department.

URAB (PDU)

This compound is similar to CMU. It has actually produced, on the average, a more lasting pre-emergence result in the field than was expected by the Chemistry Department from the findings in its greenhouse screening. URAB is a finely micronized, wettable powder containing 80 per cent pure phenyldimethylurea plus the necessary processing components used in its micronization.

Chloro IPC

In chemical screening tests, this compound was found very effective as a pre-emergence application when applied on the bare soil at the rate of from 15 to 20 pounds per acre. Its formulation was difficult at first because the compound is insoluble in water and in its natural crystal form is of such a nature that it was difficult to remove it from the container in which it was shipped. Although it was very readily soluble in any of the aromatic herbicide oils which are now being used, it was, unfortunately, necessary to heat the oil in order to dissolve the chemical in a reasonable length of time. This matter was discussed with one of the manufacturers of the compound, who arranged to ship experimental quantities to the Territory in a fluid state. This processing by the manufacturer was worked out in such a manner that an inexpensive aromatic solvent could be made to carry 70 per cent of the chemical in a stable solution. In the Chemistry Department, experimental formulation studies with the new 70 per cent solution showed that in processing it in aromatic herbicide oils, it worked rapidly and without any difficulty whatever. The formulation was made to carry one pound of the pure chemical in one gallon of an emulsion made in a manner identical to that used in the manufacture of CADE. The emulsion scheme was employed simply because the water dispersant would coagulate and separate the chemical from the oil solution, and, furthermore, if it were necessary to dilute the stock oil solution with additional aromatic oil, the costs of processing it on the plantation would be too high. By emulsifying the oil solution of the chemical, using the standard emulsifying agent E50, it is possible to dilute it to any desired volume for field use by the simple addition of water. The addition of water does not coagulate the chemical in the emulsion simply because water is in the outside phase of the emulsion, and, therefore, the addition of more water merely spreads out that phase without disturbing the emulsifying bond which holds the mixture together.

Non-Phytotoxic CADEs

During the past year, new non-phytotoxic CADEs of low viscosity have been developed for dispersing CMU, Chloro IPC, and other insoluble herbicide chemicals where aircraft application is to be made directly upon or adjacent to growing cane. In cases where such compounds cannot be dissolved in water and where an emulsion may be mixed with water without precipitating the active constituent, the vehicle used for carrying the compound must not have any deleterious effect upon the foliage of either young or older growing cane.

The development of the new non-phytotoxic vehicle included the employment of bland aliphatic mineral oils of the type which are commonly used for medicinal purposes. These oils were diluted with thinner, non-aromatic petroleum oils, which are available at low cost. No activators, aromatic oils, or other constituents were used in these non-phytotoxic CADEs. On the formulation basis, and as far as efficiency in suspending the herbicide chemicals is concerned, these new CADEs have been found entirely satisfactory. At the present time, the Agronomy Department is testing them directly on cane foliage, without addition of any herbicidal chemicals, in order to ascertain the range of non-toxicity which they may make possible.

NEW HERBICIDES UNDER CHEMICAL AND GREENHOUSE STUDY

Since the appearance of CMU, competitive manufacturers have apparently realized the value and efficiency of developing pre-emergence herbicides which, being difficultly soluble in water, resist leaching in the soils. In addition to seeking effectiveness in retarding weed development, the makers are developing chemicals which are neither readily destroyed nor chemically changed in the soil over an extended period of time, and which, furthermore, are not readily broken down by bacterial action. Several new compounds of this type have been made available for experimental study; some of them are being used on the plantations today. SESIN is one example of this type of compound; URAB is another.

The manufacturer of CMU has developed still another companion to CMU which has been sent with the request that it be put through chemical and laboratory greenhouse tests such as were carried out with CMU at this Experiment Station in 1951. On the basis of present findings in the study of this new chemical, there are several indications that it has, if anything, a more potent pre-emergence value than CMU as it is today. As to the tolerance of sugar cane and other important qualities, nothing is yet known.

The compound was submitted on a confidential basis; as its chemical composition has not been

officially announced, it bears a coded designation.

Another manufacturer has submitted a series of new pre-emergence chemicals which follow the trend mentioned above; i.e., they are insoluble in water and are designed to resist leaching and to remain active in the soil for an extended period of time. Four such new compounds, also under coded designations, will receive attention within a very short time. They are all designed as pre-emergence herbicides. A fifth, plus a chemical modification thereof, suggests a very promising approach to the problem of controlling tough grasses. These latter two chemicals are similar to hormones in that, according to the manufacturer, they operate by translocation from the blades of grass to the root systems. An outstanding feature of one of these developments is that it is freely soluble in water. The manufacturer recommends that it be applied to the grass foliage as a dilute water application in a concentration low enough so that no contact or burning effect will be produced. This will allow the grass blades to absorb and translocate it to the root systems from which, it is claimed, it will eventually destroy the entire plant. Should these two compounds prove equal to the claims made by the manufacturer, it is not difficult to foresee their extended use in the future, for no formulation has as yet been found which, when applied in low concentration to growing grass, will eventually encompass the destruction of that grass.

Another new development by yet another company consists of a "Crude Wash Oil." This oil is an inexpensive by-product from a large industrial plant in West Virginia, where new chemicals are being produced in large quantity, using the hydrogenation of coal instead of cracked petroleum as the basis for these promising syntheses. The resultant Crude Wash Oil is at present under study. It will be worked up into a formulation for field testing, should its screening in the Chemistry Department seem to warrant it.

Another by-product, known as BYLIG, comes from a manufacturing plant in the Pacific Northwest. This by-product carries sufficient free sodium hydroxide to process about two-fifths of its weight of the oil-soluble HSPA Activator. It also carries an appreciable fraction of surface active material which may enhance its value for this purpose.

Should the manufacturer make available a sufficient quantity for a more extended study, research will be continued, particularly if the quoted price of three cents per gallon still applies.

THE HSPA INHIBITOR OF CORROSION

The HSPA inhibitor of corrosion was developed originally for use by plantation men in processing TCA solutions in the plant for dilution later in field equipment. TCA is, itself, a very corrosive substance, so much so that either as a concentrate or as a diluted solution it cannot be stored in ordinary metal tanks or other storage equipment without inducing severe corrosion and, at the same time, without breaking down in its herbicide efficiency. The inhibitor of corrosion, developed in the chemistry laboratories of the Experiment Station, has been found satisfactory for plantation use. Pending the granting of a patent covering the development, it is being supplied to the plantations in dry, granular form. Up to the present time, about 3000 pounds of the inhibitor have been compounded and furnished to the plantations.

The inhibitor not only prevents corrosion when used in light concentration in TCA solutions, but it buffers the solution and holds it as its normal, slightly alkaline pH, sequestering calcium and magnesium salts which may be present in the diluting water, and precipitating in a heavy floc any insoluble matter which may be present in the commercial chemical as it reaches the plantations.

The inhibitor, its uses and applications have been discussed in the Monthly Reports, as well as in Special Releases issued to the plantations during the year.

THE FLAME PHOTOMETER—A VALUABLE INSTRUMENT

The Perkin-Elmer flame photometer continues to play an important part in the routine analytical determinations that are turned out daily on extracts of soil and plant tissue, and on water specimens. The results obtained by this technique are extremely accurate and reliable.

Two identical units have been in service for the past year in plantation crop log laboratories, the plantation personnel having been instructed in the operation and maintenance of the instrument by a staff member of the Chemistry Department. Necessary repairs and major adjustments are handled by the Instrument Shop of the Experiment Station in cooperation with the Chemistry Department.

INCREASED ATTENTION TO CHEMICAL METHODS FOR PLANTATIONS

One phase of this work comprises the checking of the laboratory performance, equipment, and reagents of plantation operators in connection with crop log determinations. It also includes the preparation, standardization, and shipment of reagents and supplies to plantation analysts engaged in these studies. In addition, courses of instruction are conducted from time to time to acquaint plantation men with details of modifications in existing procedures or to instruct new personnel in the analytical methods employed in handling the crop log specimens on the plantation premises.

The other phase of the project concerns refinements to existing analytical procedures and/or the search for new methods which would make possible the handling of crop log or other specimens in plantation laboratories with more despatch, but without sacrificing accuracy or reliability of the results obtained. A study is currently under way to ascertain the feasibility of preparing concentrates of various chemical reagents employed in plantation crop log analyses. Instructions would be included on the label of the container to guide the plantation analyst in using distilled water in making final dilution of the concentrated reagent for use in the laboratory. If successful, the plan would result in a considerable saving to the plantations in shipping charges. It would reduce the cost of preparing and standardizing these reagents and of the large number of containers that are now required for their shipment.

EFFECT OF CMU AS A HERBICIDE TESTED ON DIFFERENT SOIL TYPES

A set of percolation equipment was constructed to obtain data on the effect of CMU as a pre-emergence herbicide on several types of Island soil.

In Figure 46, A shows the sectional leaching column which makes possible the study of the percolation of herbicides through soil, A plastic tube, three inches in diameter, is cut into three-inch sections, which are joined and sealed with water pump grease when they are used as a column. The herbicide is placed at the top; leachate is removed at the bottom; and the soil is allowed to drain for 24 hours. Then the sections are cut apart, and placed in petri dishes. Seeds are germinated on top of each segment, as shown in B, C and D.

In the tests illustrated, lettuce and radish seeds were used. In each case, CMU was applied at the rate of eight pounds per acre.

In B, a test is shown in which a low humic latosol (Makiki N2) was used. A surface application of four inches of water was sufficient to leach CMU to a depth of more than six inches. As may be noted, a lethal dosage remains at the surface.

C shows the test as run on another low humic latosol (HC & S N2). In this case, the same four-inch application of water on the surface leached CMU to the same depth, but in lesser amounts.

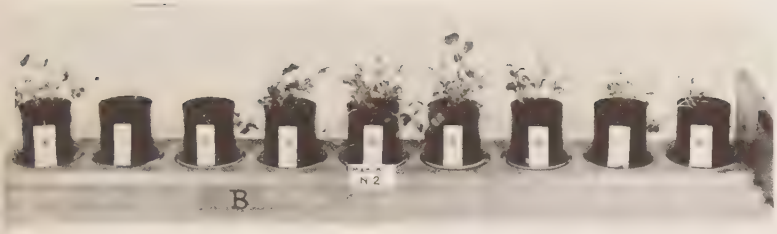
In D, the test was run on alluvial soil (H C & S VI). Here there is small indication that four inches of water leached CMU into the 3-6-inch section. Since the seedlings are growing, the CMU has evidently been removed from the surface soil. Therefore, the CMU has either been deposited in the lower portion of the 0-3-inch section, or it has become relatively inactive through biological or chemical action. This is typical of field experience with CMU on this soil. At 27 days the seedlings in the 0-3-inch section were dead, indicating that deeper root development had reached and absorbed a lethal dose of CMU.

OXALIS CONTROLLED BY REPEATED TREATMENTS OF 2, 4, 5-T AND MH 30

A fundamental fact in controlling weeds by translocated sprays was established in the control of the Pink Wood Sorrel *Oxalis martiana.* The information gleaned from a test conducted at Oahu Sugar is given.

Maleic hydrazide, when applied in 10 weekly doses at one-half pound per acre in 20 gallons of solution, shows effective control after 75 days, or 12 weeks. When five applications at this same rate were made on alternate weeks, there was no effective control at any time.

Weekly applications of maleic hydrazide at the rate of one pound per acre in 20 gallons of solution, revealed effective control after 10 applications, or 70 days. Satisfactory control resulted at the end of 12 weeks when five pounds were put on in bi-weekly one-pound applications.



B. Low Humic Latosol (Makiki N2)

X—Check. No treatment.
1—0-3" section. All seedlings killed or stunted.
2—3-6" section. CMU has reached this depth in lethal concentration.
3—6-9" section. Trace symptoms of CMU.
4 to 8—9-24" sections. No CMU symptoms.

C. Low Humic Latosol (HC&S N2)

X—Check. No treatment.
1—0-3" section.
2—3-6" section. CMU present but only partially lethal.
3—6-9" section. Trace symptoms of CMU.
4 to 8—9-24" sections. No CMU symptoms.

D. Alluvial Soil (HC&S VI)

X—Check. No treatment.
1—0-3" section.
2—3-6" section. Only small effect of CMU.
3 to 8—6-24" sections. No effect of CMU.

Figure 46. Sectional leaching column for studying percolation of herbicides through soils. The leaching column is made in three-inch sections which are sealed together with water pump grease. Each segment is cut away after the herbicide has been leached and the soil is drained. They are then numbered and placed in petri dishes. The effectiveness of the herbicide in the soil can be determined by the reactions of the seedlings which are planted in each section. The pictures were taken 19 days after CMU had been applied at the rate of 8 pounds per acre. Lettuce and radish seeds were used.

Where weekly half-pound per acre applications of 2, 4, 5-T were made, effective control appeared after 56 days, or eight applications. This control slipped, and an additional application was necessary to eradicate the growth. At two-week intervals, applications of one-half pound per acre failed to give adequate control. As satisfactory control was obtained when one pound of 2, 4, 5-T per acre was applied weekly for four consecutive weeks, it would appear that this is the best way to apply this herbicide. Single applications of as high as five pounds 2, 4, 5-T per acre have resulted in only about 10 per cent total kill.

COOPERATIVE FIELD TESTING PROFITABLE

In speaking of tests, use of the adjective "cooperative" describes those tests which have been conducted cooperatively by plantations, Island Representatives, and Station personnel. It does not mean tests set up and conducted by the plantations alone. While several plantations have organized tests of their own, information on such tests is not available. It is the objective of this project to make every test cooperative, except in the rare cases where the information obtained is from and for a condition which is unique.

In the cooperative tests run this year, CMU has continued to be the principal material studied, though several new herbicides, such as Chloro IPC, borates, and two coded compounds known as K-D and K-T, have been included in the program.

Sixty-four tests were made cooperatively with a majority of the plantations, including 25 on Hawaii, 5 on Maui, 21 on Oahu and 13 on Kauai.

1. In a test of CMU in CADE applied to a dense mat of manienie at Kahuku, the following periods of control were obtained:

Pounds CMU/Acre	Gallons per Acre	Period of Control Days	Month
5.0	50	10	0.3
10.0	50	30	1.0
25.0	50	81	2.7
50.0	50	120	4.0
75.0	50	145	4.8
100.0	50	182	6.1

At two months, it appeared that all dosages of 25 pounds per acre up showed better than 95 per cent kill of manienie; but at the end of that period, new growth started from surviving root tissue.

A similar test was set up on general roadside weeds at Kahuku, including such species as Spanish needle, sow thistle, crotalaria, wire grass, graceful spurge, garden spurge and Flora's paintbrush. In this case, 5.0 pounds CMU gave control for 119 days. At 221 days (7.4 months), all of the other dosages of 10, 25, 50, 75, and 100 pounds CMU per acre were still giving satisfactory control. This test was on shallow soil on coral base.

The spurges were the first species to re-emerge on the 5.0 pound plots.

2. In seven tests on Hawaii, the following information was developed:

(a) CMU at 5.0 pounds per acre gave equal or longer control than any other formulation tested.

(b) The 2,4-D plus TCA mix gave equal or longer control than 2,4-D alone.

(c) 2,4,5-T gave only slightly longer control than 2,4-D.

(d) Micronized 2,4-D acid at equal dosage with water-soluble 2,4-D did not give longer control.

3. No CMU damage has been noted from any airplane application. Damage from over-application has resulted from treatments by both tractors and spray gangs, indicating that such operations need closer control.

4. Tests on Kauai have given the following information on the use of CMU:

(a) Apparently during the period of testing, weather conditions, and possibly other factors, were not conducive to weed development, as evidenced by the long periods during which the check plots remained clean. Nevertheless, data on CMU for pre-emergence were obtained.

(b) The shortest and longest periods of control are indicated for each level of CMU.

0.0 lbs. CMU (check plots)	15 to 45 days
2.0 lbs. "	23 to 84 "
4.0 lbs. "	28 to 84 "
6.0 lbs. "	40 to 85 "
8.0 lbs. "	42 to 92 "

(c) The periods of control attained from 2.0 pounds CMU per acre indicate that even this low amount of CMU may have considerable value, especially if used as repeat

treatments. More consistently satisfactory results would undoubtedly result from four to six pounds per acre; five pounds per acre is currently recommended.

(d) No deleterious effects on cane from 5 pounds CMU were noted in any of these tests, but some effect is shown from 10-pound applications.

(e) The poorest results were obtained in Field K-25 at Grove Farm, on soil classified as the Waikaloa family, shallow and stony phase. It appears that the soil type in this case has had an effect on duration of control, as no marked differences can be found between different locations on other soil families.

5. Tests with Chloro IPC have shown the following:

(a) At Oahu Sugar, five pounds CIPC gave 39 days control, 10 pounds 44 days, and 15 pounds 48 days. From this test, the 10 pound per acre application seemed to be optimum.

(b) In another test at Oahu Sugar, five pounds CIPC gave 29 days control as compared with 39 days given by five pounds CMU applied in CADE.

6. Tests with borates have shown that polyborchlorate at 500 and 1000 pounds per acre has value for weed control around storage areas. Sugar cane has shown only slight toxicity from applications of 1000 pounds borate per acre.

MIXER FOR NEW HERBICIDES DEVELOPED

The unit shown in Figure 47 is a small pilot plant mixer for preparing new herbicidal formulations in one- to five-gallon vats. It contains a circulatory pump system, a heating unit, a mixing shaft and beater, and a strainer and hose-line for transfer of liquids.

This unit was constructed by and in cooperation with the Sasaki Welding Shop in Honolulu.

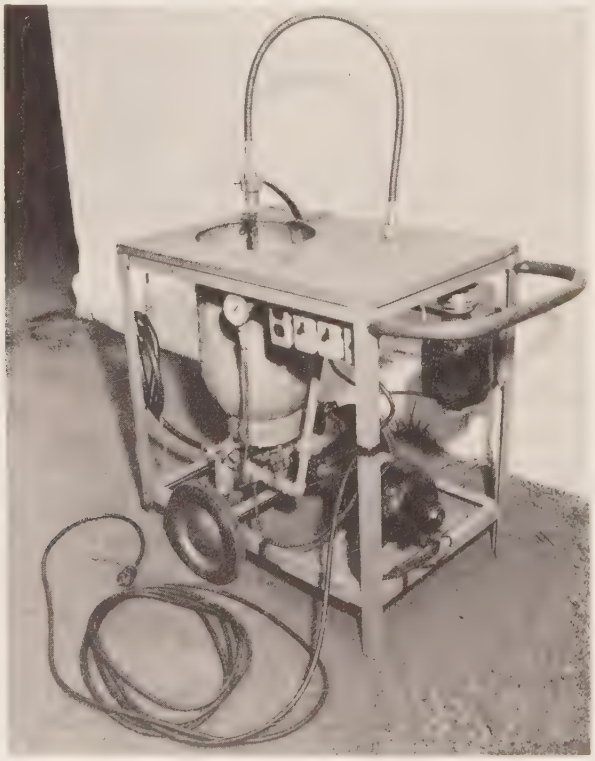


Figure 47. Pilot plant mixer for preparing new herbicidal formulations in one- to five-gallon vats.

Figure 48. In the cluster-type (Hutchinson) pressure knapsack unit, liquid is pumped in at the bottom of the front tanks, forcing the air over into the rear tank. Note the locations of the pressure gauge, tank valve and pop-off safety valve on top. The pressure regulator and injector coupler are at the bottom. Note the strainer handle valve and three-nozzle arrangement.

Figure 49. The inline-type (Kilauea) pressure knapsack unit is arranged with its three tanks in a row along the back plate, with parallel piping at both top and bottom so that all three tanks contain both liquid and air. The fittings are the same as on the cluster-type knapsack with the exception of the nozzle.

PRESSURE KNAPSACKS INCREASE IN POPULARITY

During 1953, the major interest in spray equipment centered in pressure knapsacks and the supply units to serve the spray gangs in the field. Continued consultations have resulted in the adoption by 19 plantations of pressure tanks and infield supply units.

Two new types of knapsack were completed in 1953. Both use the same type of tank, but the arrangement is different. The Cluster-type (Hutchinson) pressure knapsack uses two of its three 500 cubic inch tanks to carry the spray liquid. The third carries air only. The three are mounted in a clover-leaf arrangement and are shown in Figure 48. The other type of pressure tank, the Inline-type (Kilauea) is pictured in Figure 49. Here, all three tanks, arranged in a row along the back plate, contain both air and spray liquid which is made possible by the parallel piping at both top and bottom. The fittings on both units are identical, except for the nozzles. For further information on these units, consult Special Release 76 from this Station.

Those plantations located on Hawaii are: Hutchinson, Hilo Sugar, Onomea, Hakalau, Laupahoehoe, Hamakua Mill and Paauhau; on Kauai: Kilauea, Lihue, Grove Farm, McBryde, Olokele and Kekaha; on Maui: H C & S, Pioneer and Wailuku; and on Oahu: Ewa, Oahu Sugar and Kahuku.

MISCELLANEOUS

WHAT'S NEW IN RODENTICIDES

"COUMACHLOR" is a coined name for the compound previously referred to as Tomorin and as Geigy Rodenticide Exp. 332. The name "Coumachlor" applies to 98 per cent purified chemical compound used in the formulations of bait concentrates. Bait mixtures are prepared in the same manner and concentration used with Warfarin. Tests with Tomorin, now Coumachlor, continue to show results equal to those shown by Warfarin.

"Pival" is the name of another anti-coagulant rodenticide which has been tested in cages during the past year. It has proved to be equally efficient to Warfarin in all respects. It has also been accepted for general registration by the Production and Marketing Administration.

Thus, there are now three satisfactory anti-coagulants available for use in rodent control.

TRAINING PLANTATION PERSONNEL

Figure 50. Assistant-in-Training in Sugar Factory Technology, 1953-1955. Myron H. Caplin. Not pictured, Melvin K. Thompson.

Figure 51. Assistants-in-Training in Agriculture, 1953-1955. From left to right: Robert P. Gagner, Thomas J. O'Brien, Howard Hoshide, Raymond Aea, F. E. Sutherland, Herbert L. Rubin, Howard E. Wagoner, John C. Hance.

EXPERIMENT STATION STAFF

ADMINISTRATION

L. D. BAVER.....*Director*
H. L. LYON.....*Consultant*

Business Office

A. R. GRAMMER.....*Senior Office Manager*
F. WM. LITTLEJOHN.....*Associate Office Manager*

Publications and Visual Aids

L. D. BAVER.....*Editor*
R. J. LEFFINGWELL.....*Consultant*
LYDIA C. NICKERSON.....*Associate Editor*
J. T. YAMAMOTO.....*Photographer and Illustrator*

Library

MABEL FRASER.....*Senior Librarian*
JEAN DABAGH.....*Assistant Librarian*

Buildings and Grounds

WILLIAM SA NING.....*Superintendent*
EDWIN CHUN.....*Field Foreman*

Island Representatives

HAWAII

O. H. LYMAN.....*Senior Island Representative*
K. L. BOND.....*Assistant Island Representative*
A. SATO.....*Substation Overseer*
D. MONIZ.....*Substation Assistant*
H. OBA.....*Substation Assistant*
Y. SUGAWARA.....*Substation Assistant*

OAHU

F. C. DENISON.....*Senior Island Representative*
J. B. MENARDI.....*Associate Island Representative*
B. K. NISHIMOTO.....*Substation Overseer*
J. BUMANGLAG.....*Substation Assistant*
L. NAKATSUKA.....*Substation Assistant*
C. G. SUERO.....*Substation Assistant*

KAUAI

D. S. JUDD.....*Senior Island Representative*
Y. INOUYE.....*Substation Overseer*
A. T. TOGIKAWA.....*Substation Assistant*

AGRICULTURAL ENGINEERING

R. A. DUNCAN.....*Principal Agricultural Engineer*

E. R. BOLLES.....*Senior Design Engineer*
A. K. HANSEN.....*Senior Design Engineer*
W. E. HART.....*Associate Agricultural Engineer*
J. M. NUTTER.....*Associate Agricultural Engineer*
W. J. TEMPAS.....*Associate Agricultural Engineer*
T. ADACHI.....*Assistant Engineer*
D. M. BURNS.....*Assistant Agricultural Engineer*
S. MATSUOKA.....*Assistant Mechanical Engineer*
E. M. NORUM.....*Assistant Agricultural Engineer*
Y. ISA.....*Mechanic*
C. K. MAHOE.....*Mechanic*
K. TOGASHI.....*Machinist*
E. T. TORRICER.....*Mechanic*
T. USHIGOME.....*Machinist*

AGRONOMY

R. P. HUMBERT.....*Principal Agronomist*

A. S. AYRES.....*Senior Agronomist*
R. B. CAMPBELL.....*Senior Agronomist*
N. S. HANSON.....*Senior Agronomist*
A. H. CORNELISON.....*Associate Agronomist*
R. E. DOTY.....*Associate Agronomist*
A. C. TROUSE, JR.....*Associate Agronomist*
H. HAGIHARA.....*Assistant Agronomist*
T. A. JONES.....*Assistant Agronomist*
J. A. SILVA.....*Assistant Agronomist*
H. ASATO.....*Agronomy Assistant*
A. Y. CHING.....*Agronomy Assistant*
W. T. GOTO.....*Agronomy Assistant*
M. Y. LUM.....*Agronomy Assistant*
Y. YAMASAKI.....*Agronomy Assistant*

BOTANY

H. L. LYON.....*Botanist*
COLIN POTTER.....*Nursery Superintendent*

BY-PRODUCTS

G. W. ALJIAN.....*Coordinator*

T. J. NELSON.....*Consultant*
W. A. ROBINSON.....*Sr. Pulp and Paper Technologist*
R. W. F. MOREL.....*Senior Chemical Engineer*
S. B. KNAPP.....*Assoc. Pulp and Paper Technologist*
T. YAMAMOTO.....*Assistant Technologist*
M. AMAKI.....*Pilot Plant Technician*

CHEMISTRY

F. E. HANCE.....*Principal Chemist*
RICHARD BOYEN.....*Executive Assistant*
M. DOI.....*Associate Chemist*
Q. H. YUEN.....*Associate Chemist*
G. C. BATTLE, JR.....*Assistant Chemist*
T. S. JONES.....*Assistant Chemist*
H. M. LEE.....*Assistant Chemist*
GEORGE UYEHARA.....*Assistant Chemist*
GEORGE KOIZUMI.....*RCM Technician*
HENRY MAU.....*Analyst*
C. T. NAKAGAWA.....*Laboratory Technician*
E. S. YAMAMOTO.....*Laboratory Technician*

ENTOMOLOGY

C. E. PEMBERTON.....*Principal Entomologist*
R. H. VAN ZWALUWENBURG.....*Senior Entomologist*
F. A. BIANCHI.....*Associate Entomologist*
E. C. ZIMMERMAN.....*Associate Entomologist*
J. S. ROSA.....*Laboratory Technician*

EXPERIMENTAL STATISTICS

R. J. BORDEN.....*Principal Statistician*
R. K. TANAKA.....*Assistant Statistician*
P. VICTORIA.....*Drafting Technician*

GENETICS

A. J. MANGELSDORF.....*Principal Geneticist*
J. N. WARNER.....*Senior Geneticist*
R. URATA.....*Associate Geneticist*
A. DOI.....*Assistant Geneticist*
M. TANAKA.....*Supt. Kailua Field Laboratory*
R. CHI.....*Genetics Assistant*
N. KIMURA.....*Genetics Assistant*
K. NISHIMOTO.....*Genetics Assistant*
K. SADANAGA.....*Genetics Assistant*
H. TERAYAMA.....*Genetics Assistant*

GEOLOGY

D. C. COX.....*Senior Geologist*

METEOROLOGY

W. A. MORDY.....*Meteorologist* (Cooperative with PRI)
GORDON FURMIDGE.....*Assistant Meteorologist, Instrument Specialist*
T. HAYASHI.....*Laboratory Technician*

PATHOLOGY

J. P. MARTIN.....*Principal Pathologist*
C. A. WISMER.....*Associate Pathologist*
H. KOIKE.....*Assistant Pathologist*

PHYSIOLOGY AND BIOCHEMISTRY

G. O. BURR.....*Principal Physiologist and Biochemist*
H. W. BRODIE.....*Senior Physiologist*
CONSTANCE E. HARTT.....*Associate Physiologist*
H. P. KORTSCHAK.....*Associate Biochemist*
A. R. LAMB.....*Associate Biochemist*
F. M. ASHTON.....*Assistant Biochemist*
ADA FORBES.....*Assistant Physiologist*
DAVID TAKAHASHI.....*Assistant Biochemist*
T. TANIMOTO.....*Assistant Biochemist*

SUGAR TECHNOLOGY

J. H. PAYNE.....*Principal Technologist*
G. E. SLOANE.....*Senior Technologist*
R. K. HAMILTON.....*Associate Technologist*
H. I. MAHON.....*Associate Technologist*
L. J. RHODES.....*Associate Technologist*
F. J. DUPIN.....*Scale Inspector*
A. C. FONG.....*Laboratory Technician*
H. S. IWATA.....*Laboratory Technician*
RAY SPELLMAN.....*Laboratory Technician*
W. R. WAKATSUKI.....*Laboratory Technician*

TRAINING OF PERSONNEL

Assistants-in-Training

AGRICULTURE

R. T. F. AEA
C. H. BOND
W. J. CRITTENDEN
R. P. GAGNER
J. C. HANCE
H. H. HOSHIDE
T. KONO
T. J. O'BRIEN
A. G. ROGERS
H. L. RUBIN
F. E. SUTHERLAND
P. R. VAN ZWALUWENBURG
H. E. WAGONER
R. J. WINANS

SUGAR TECHNOLOGY

M. H. CAPLIN
S. T. OOKA
M. K. THOMPSON

STATION PERSONNEL CHANGES

October 1, 1952 – September 30, 1953

JOINED THE STAFF

Aea, R. T. F.	*Assistant-In-Training*	Training Personnel
Burns, D. M.	*Assistant Agricultural Engineer*	Agricultural Engineering
Campbell, R. B.	*Senior Agronomist*	Agronomy
Caplin, M. H.	*Assistant-In-Training*	Training Personnel
Gagner, R. P.	*Assistant-In-Training*	Training Personnel
Goto, W. T.	*Agronomy Assistant*	Agronomy
Hance, J. C.	*Assistant-In-Training*	Training Personnel
Harris, Mrs. Esther	*Secretary*	Physiology & Biochemistry
Holck, Mrs. C. J.	*Stenographer*	Agronomy
Hoshide, H. H.	*Assistant-In-Training*	Training Personnel
Kitagawa, W. K.	*Laboratory Helper*	Sugar Technology
Koenig, Miss M. A.	*Laboratory Helper*	Physiology & Biochemistry
Middleton, C. R.	*Field Helper*	Genetics
Morel, R. W. F.	*Senior Chemical Engineer*	By-Products
Norum, E. M.	*Assistant Agricultural Engineer*	Agricultural Engineering
O'Brien, T. J.	*Assistant-In-Training*	Training Personnel
Oyama, R. Y.	*Drafting Helper*	Geology
Rubin, H. L.	*Assistant-In-Training*	Training Personnel
Shimabuku, Miss N. S.	*Laboratory Helper*	Agronomy
Sloane, G. E.	*Senior Technologist*	Sugar Technology
Sutherland, F. E.	*Assistant-In-Training*	Training Personnel
Thompson, M. K.	*Assistant-In-Training*	Training Personnel
Togikawa, A. T.	*Substation Assistant*	Kauai Substation
Togashi, K.	*Machinist*	Agricultural Engineering
Torricer, E. T.	*Mechanic*	Agricultural Engineering
Ushigome, T.	*Machinist*	Agricultural Engineering
Wagoner, H. E.	*Assistant-In-Training*	Training Personnel
Wakatsuki, W. R.	*Laboratory Technician*	Sugar Technology
Watson, Mrs. B. L. F.	*Stenographer*	Agronomy
White, Randall	*Stenographer-Clerk*	By-Products

ON LEAVE OF ABSENCE FOR MILITARY DUTY

Imamura, Robert	*Field Helper*	Genetics
Lee, Dennis K. P.	*Drafting Helper*	Geology
May, C. W., Jr.	*Assistant-In-Training*	Training Personnel
Nelson, Victor J.	*Assistant-In-Training*	Training Personnel
Palmer, Marshall T.	*Assistant-In-Training*	Training Personnel
Ogasawara, Edwin T.	*Assistant-In-Training*	Training Personnel
Vorfeld, Robert T.	*Assistant-In-Training*	Training Personnel
Wright, W. R.	*Assistant-In-Training*	Training Personnel

LEFT THE STAFF

Baba, E. H.	*Laboratory Helper*	Sugar Technology
Ballinger, D. K.	*Assistant-In-Training*	Training Personnel
Bowman, I. W.	*Assistant-In-Training*	Training Personnel
Brosnan, Mrs. S. G.	*Stenographer*	Agronomy
Budge, A. G., Jr.	*Assistant Engineer*	Agricultural Engineering
Buenaventura, Mrs. E. C.	*Typist-Clerk*	Oahu Substation
Chalmers, Mrs. E. D.	*Typist-Clerk*	Oahu Substation
Chun, K. K. L.	*Machinist*	Agricultural Engineering
Clay, H. F.	*Assistant-In-Training*	Training Personnel
Doyle, B. K.	*Livestock Nutritionist*	By-Products
Gardner, J. D.	*Assistant-In-Training*	Training Personnel
Hart, C. W., Jr.	*Senior Design Engineer*	Agricultural Engineering
Herkes, J. W.	*Assistant-In-Training*	Training Personnel
Heyd, P. V., Jr.	*Assistant Island Representative*	Hawaii Substation
Inouye, T.	*Assistant-In-Training*	Training Personnel
James, R. G.	*Assistant-In-Training*	Training Personnel
Katano, J. K.	*Laboratory Helper*	By-Products
Kenda, William	*Senior Technologist*	Sugar Technology
Knowles, R. E.	*Laboratory Technician*	Sugar Technology
Kobori, S.	*Drafting Technician*	Experimental Statistics
Lizardo, E. P.	*Cowboy*	By-Products
Marks, Miss L. M.	*Secretary*	Botany
Matsumura, Donald	*Laboratory Helper*	Meteorology
Matsuura, M.	*Caretaker, Manoa Arboretum*	Botany
Mukai, T.	*Substation Overseer*	Maui Substation
Racoma, F. M.	*Laboratory Helper*	Publications & Visual Aids
Robinson, R. S.	*Assistant-In-Training*	Training Personnel
Shimabukuro, M.	*Mechanic*	Agricultural Engineering
Shiosaki, J.	*Field Helper*	Genetics
Sideris, P. M.	*Assistant-In-Training*	Training Personnel
Sodetani, K.	*Laboratory Helper*	By-Products
Spencer, E. W.	*Assistant-In-Training*	Training Personnel
Stirniman, E. J.	*Consultant*	Agricultural Engineering
Sugimoto, T.	*Substation Helper*	Maui Substation
Takajo, M.	*Machinist*	Agricultural Engineering
Tyau, Harvey	*Laboratory Technician*	Physiology & Biochemistry
Wadsworth, H. A.	*Collaborator in Irrigation*	Training Personnel
Wallis, C. T.	*Assistant-In-Training*	Training Personnel
Watson, Mrs. B. L. F.	*Stenographer*	Agronomy

1953 Report

Experiment Station Committee

Hawaiian Sugar Planters' Association